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HEINRICH SCHLIEMANN.

WE present herewith a portrait of this great archæologist and also a number of engravings of some of the most interesting objects brought to light by his efforts, for which we are indebted to the *Illustrirte Zeitung*.

Our contemporary says:

"Schuchhardt says that Schliemann's manner of excavating and exploring is so characteristic of the man that it is impossible to understand one without a knowledge of the other. Schliemann was one of the few men in whom the sense of the ideal was closely united with the real.

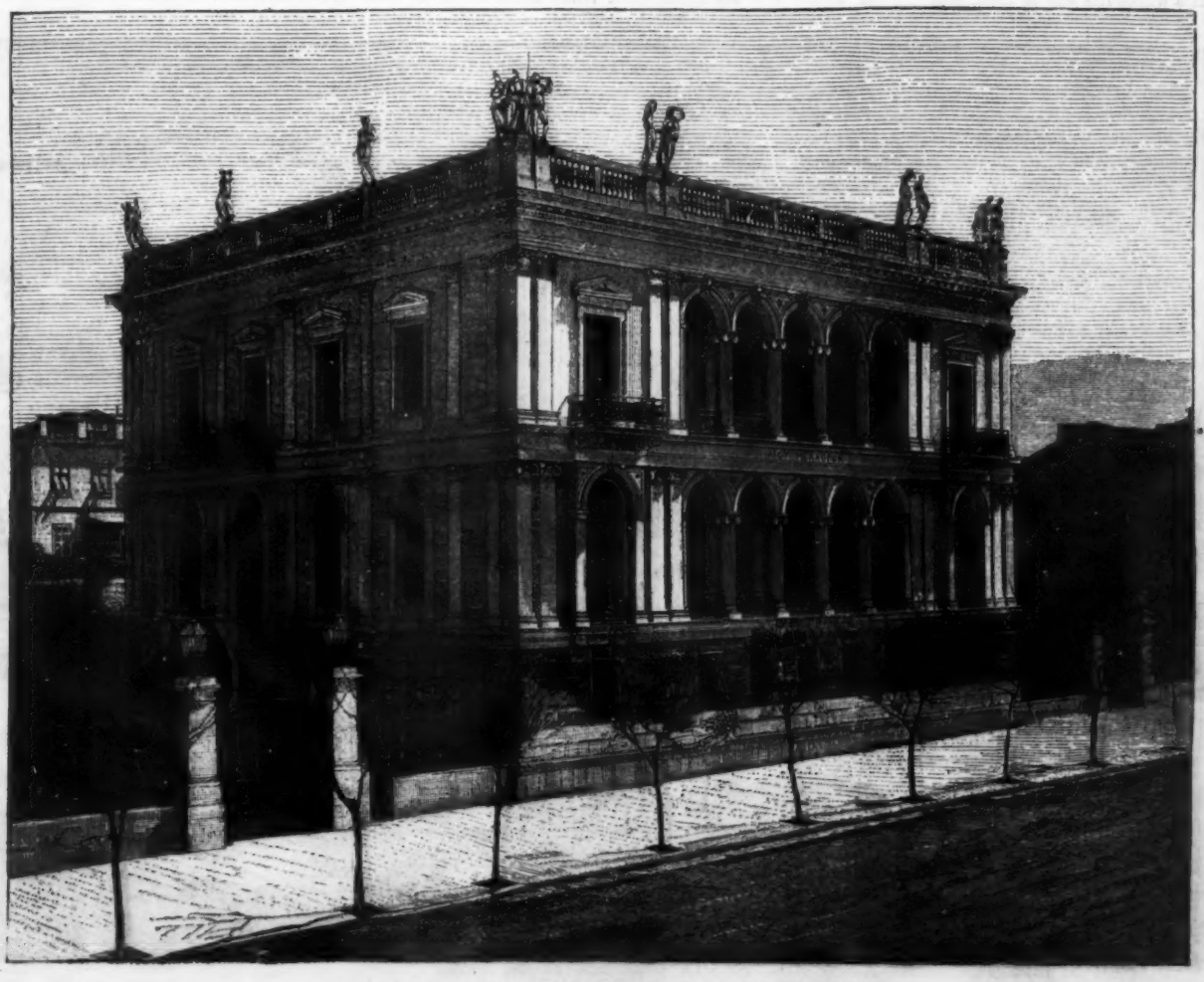
"He was an enthusiast in regard to antiquities, and at the same time an excellent business man. These two features of his character explain his success. After long years of apprenticeship and travel, persevering industry and his great ability as a merchant brought him means by which he was able to realize his plans. The Ilium of Homer's heroic song—so rich in tradition—and all that was buried with it, had attracted him strongly, even as a boy. 'Often my father related to me,' so he writes in his autobiography, 'the deeds of Homer's heroes and the events of the Trojan war, and he always found in me a champion of Trojan affairs. With grief I learned from him that Troy had disappeared so completely from the face of the earth that not a trace of it was left.' The boy thought over the subject, and then asked his father whether Troy really had such strong walls as she was represented with, and when his father answered in the affirmative, he said, 'Father, if there ever were such walls, they cannot have been utterly destroyed, they must be hidden under the dust and accumulations of centuries.' It is known how this thought of the boy constantly influenced the youth and man, and how the resuscitation of the Hellenic heroes in the very places celebrated by the poet, the monumental remains of past ages found through his efforts, and the gradual realization of his fantastic fancies and unconquerable hope, has placed before us a picture of ancient Greek civilization.

HEINRICH SCHLIEMANN.

"The principal work, the excavation of Troy, was begun in 1870. In a series of excavating campaigns, he unearthed here a great number of interesting articles, relics of former rulers and an antique civilization. As long as he lived he imposed on himself the task of subjecting everything that was found, then and there, to scientific tests, and rejecting all which did not stand this test. The excavation of other celebrated centers of civilization was, from the first, included in his plan. By the summer of 1868 he had already traveled through Peloponnesus, the island of Odysseus, and Asia Minor, and in a report of this journey he traced out the course which he afterward successfully followed in his excavations.

"In the course of time he had broken ground at Orchomenos, Tiryns, and other places besides Ilium and Mycenæ, and his good luck as an explorer never forsook him. With the aid of tried archæologists he collected the results of these excavations in five large works, provided with numerous illustrations, showing the excavations and the objects found therein. These works were published by F. A. Brockhaus, and their titles are as follows: 'Ithaca, Peloponnesus, and Troy' (1869), 'Mykenæ' (1878), 'Ilios' (1881), 'Troja' (1884), 'Tiryns' (1886).

"Of his other works we may mention 'Bericht uber seine Ausgrabungen in Orchomenos' (1881), 'Eine Reise in die Troas' (1881), and an atlas of ancient Troy (1874). Schuchhardt also wrote a long report of these discoveries in the work already mentioned, 'Schliemann's Ausgrabungen in Troja, Tiryns, Mykenæ, Orchomenos, Ithaka im Lichte der heutigen Wissenschaft' (Leipzig, 1890), in connection with a life-like biographical sketch of Schliemann. We recommend all of these works to those who are interested in Schliemann's excavations.



SCHLIEMANN'S RESIDENCE IN ATHENS.

"The whole German nation feels greatly indebted to Heinrich Schliemann, on account of the immense service rendered by his discoveries to the science of archæology, and more especially to the history of the oldest Greek history and art. It is well known that the greater part of the objects discovered by him at Troy were sent to the Museum of Ethnology in Berlin, only a small part going to or rather remaining in Constantinople.

"It is said that, according to the directions of his will, the treasures kept by him in his house in Athens will also be sent to the Berlin museum. It is unnecessary to point out the great value of this magnanimous gift to German scholars. This patriotic mind, with its high aims and self-sacrificing readiness to help German science and its representatives in the south, will never be forgotten.

"His mortal remains found their last resting place on the 'Kolonoshugel' near Otfried Muller, and with him he will always live in the minds of the present and future generations as the corypheus of archæology."

FRAGMENT OF A PAINTED VASE OF THE LAST PERIOD FROM MYCENA.

GOLDEN DEATH MASK FROM THE FIRST GRAVE IN MYCENA.

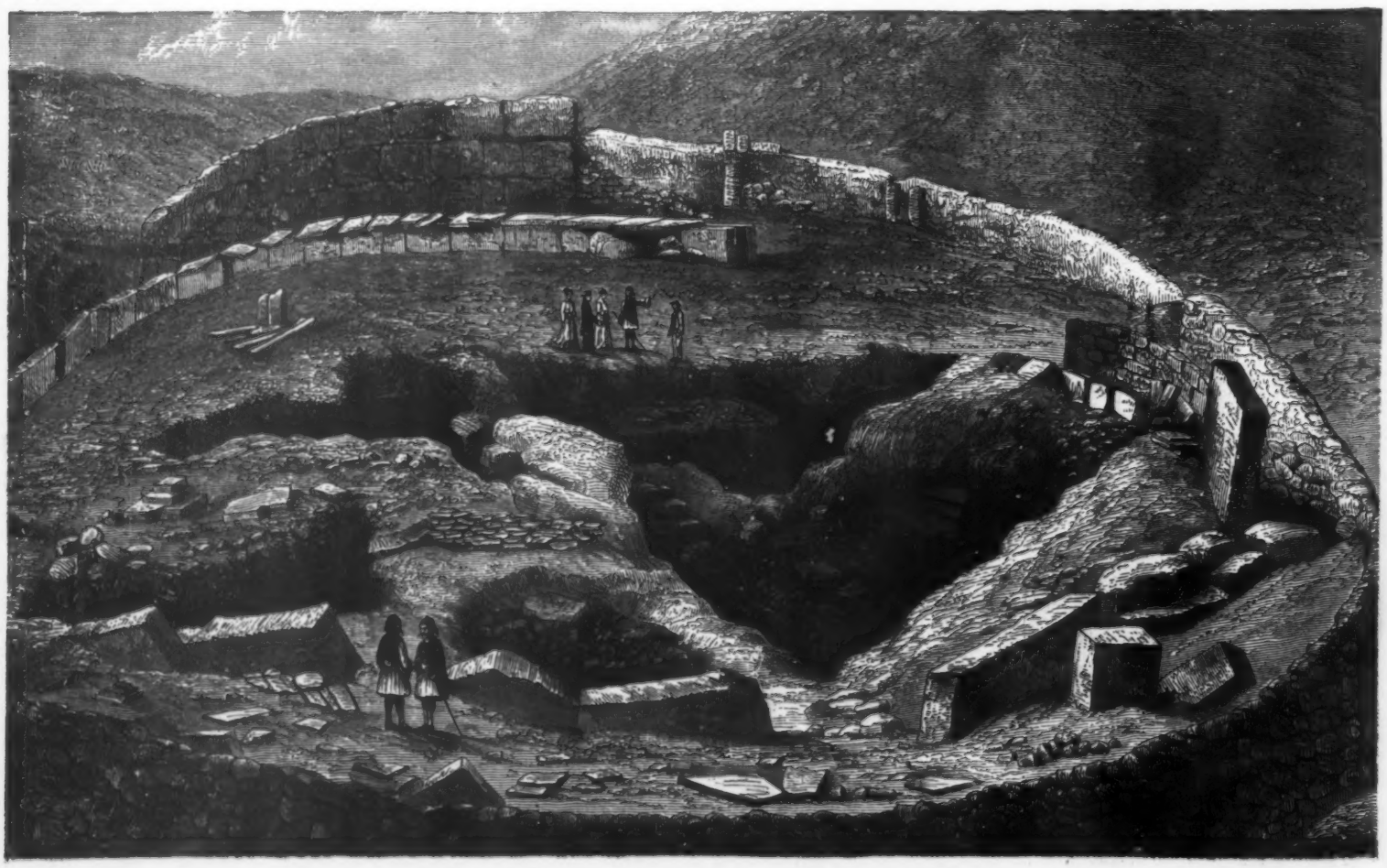
THE IMPORTANCE OF SCHLIEMANN'S EXCAVATIONS.

There has long been a great diversity of opinion in regard to the scientific importance of Heinrich Schliemann's work. His whole life was a hard struggle for financial success, which, although won slowly, was ultimately very great; and in his scientific career his experience was the same. He met distrust on all sides, and many called him a dreamer, without critical judgment. When, in his first enthusiasm, he connected the names of certain heroes of the old Greek poems —such as Priam and Agamemnon—with his discoveries, even careful thinkers became suspicious. The general public thought him a man who "dug for treasures and was happy if he found earth worms." He aroused the disapproval of archæologists by his manner of digging; that is, his over-hasty work without giving special attention to historical strata through which he passed.

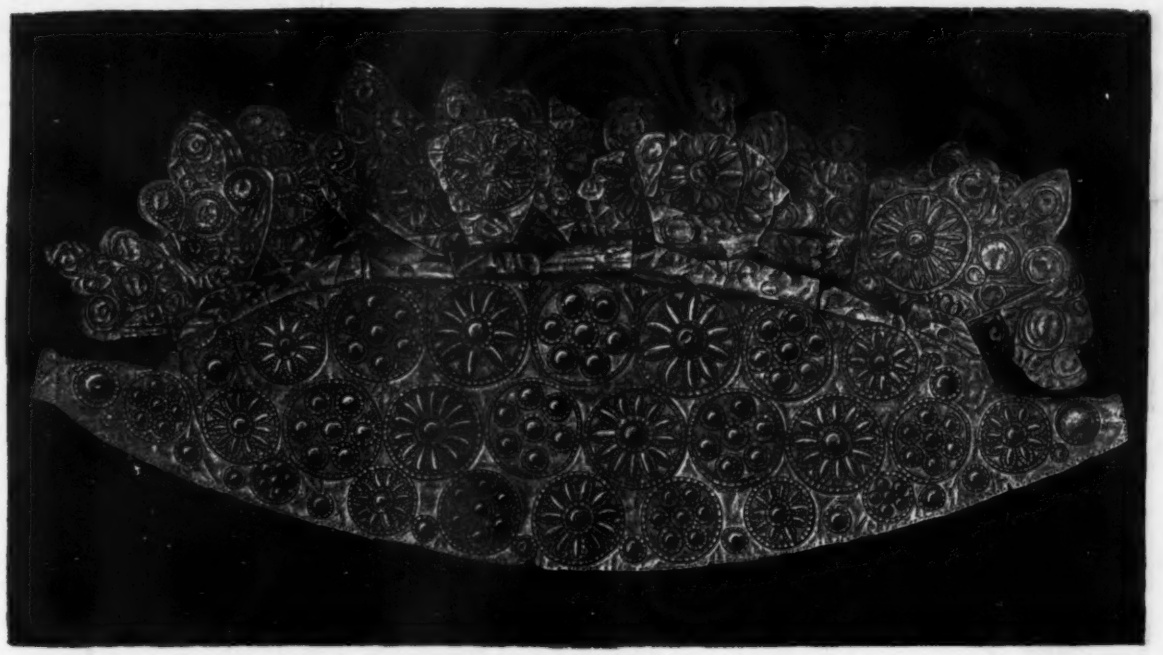
Until we understand the obstacles he overcame it is impossible to appreciate the energy of the man. The treasure seeker became a scholar, the reckless enthusiast a prudent, cautious investigator whose name is inseparably connected with the archæology of the last generation of the nineteenth century; and, indeed, the importance of his work lies, not in the material success of his search in the bowels of the earth, not in the certainty that through him old Ilium, the fall of which was sung by Homer, has been found again. Schliemann has opened up a new era for those explorers who are interested in the early civilizations of the region about the Mediterranean Sea. That is better than having found Troy. We could quote favorable criticism of many learned men, but prefer to show that Schliemann was much more than the "discoverer of Troy," by which title he is best known.

Our historical knowledge of classical antiquity from authentic writings ends at the eighth century before Christ, and from that time until Schliemann's day we have only legends, tradition and poetry. He found so many proofs of the important events related of this period that we have a monumental history verifying the traditions in which we had ceased to believe. The skulls discovered in Troy and Mycena furnish ethnologists with proofs of the existence of a long vanished race; and palæontology found, in the utensils unearthed, a standard for the development of civilization. The unglazed vases were specially significant. "Clay," said Brongniart, "is the most durable material of any of which human productions are made." In fact, earthenware articles, which are the oldest relics found with the remains of men and animals, are like a sign post on the way, indicating the direction taken by civilization.

As they have an individual, artistic character, in form and decoration, they are the earliest tokens of the artistic spirit of a people, and here lies the boundary where the representatives of palæontology and artistic archæology meet. The latter have not delayed in making the best scientific use of the treasures offered them, and Adolf Furtwangler and Georg Losche found here material for a work on the earliest specimens of the plastic art in the region of the Mediterranean. Archæologists have also obtained im-



THE CIRCLE OF GRAVES IN THE FORTRESS OF MYCENA.

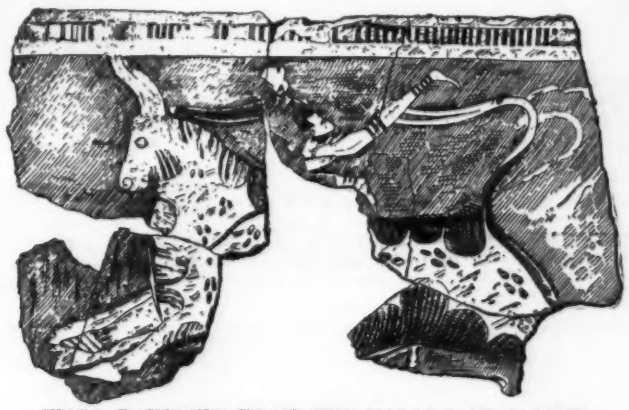


LARGE GOLD DIADEM FROM THE THIRD GRAVE AT MYCENA. (½ natural size.)

portant information in regard to the working of precious metals, a knowledge which will be increased when more is learned about the origin of this work and the models used; and even the unprofessional can understand that these monumental remains throw great light on the history of architecture.

GOLDEN CUP FROM THE FOURTH GRAVE IN MYCENA.

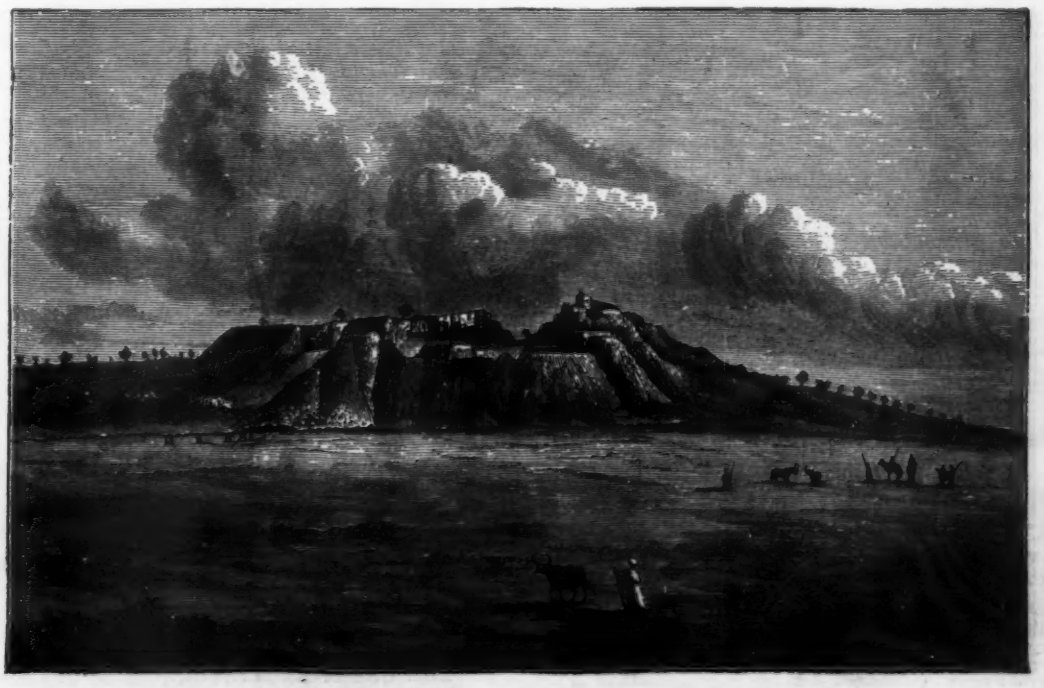
Adler, who wrote the introduction to Schliemann's "Tyrins," tried to explain the significance of the immense remains of buildings belonging to the traditional past, but it was Wilhelm Dorpfeld who recognized, in the confusion of the ruins, the former appearance of things and presented them to the mind's eye. Even the details of the ground plans of the palaces, the decorations of their walls, and the ornamentation of their stone roofs are brought before us; the domes of the sepulchers receive again the metal covering with which their walls were decorated. It is scarcely necessary to state that investigators in all departments have worked together to produce a complete history, and that historians are working diligently to read this history from the inscriptions on the stones. The fact just mentioned of the finding of the "brazen walls" in the houses of the dead shows the importance of the excavations in proving the authenticity of the traditions of the old poem. The "fabulous gold" of Homer is made tangible by the imposing treasures found, of which a dynasty of our day would have no reason to be ashamed. Every sincere philologist who considers more than the pure history of the language in reading the poems finds it impossible to escape the influence of Schliemann's conquest; and the topographer has reason to be thankful, not only for the discovery of important places, the names of which are connected with the lives of the ancients, but also, and more especially, for a new standard by which to judge the authenticity of old writings.



WALL PAINTING FROM THE PALACE OF TIRYNS.

By Schliemann's discovery we are suddenly brought close to the characters of the Greek poems; we see

UPPER PART OF A BODY FOUND IN THE FIRST GRAVE AT MYCENA.



TROY, AS IT LOOKED AFTER THE EXCAVATION FROM 1871 TO 1873. NORTH SIDE.

their armor, we know the walls of their cities, we have the cups from which they drank, yes, we see the duplicates of their faces in the golden death masks. We

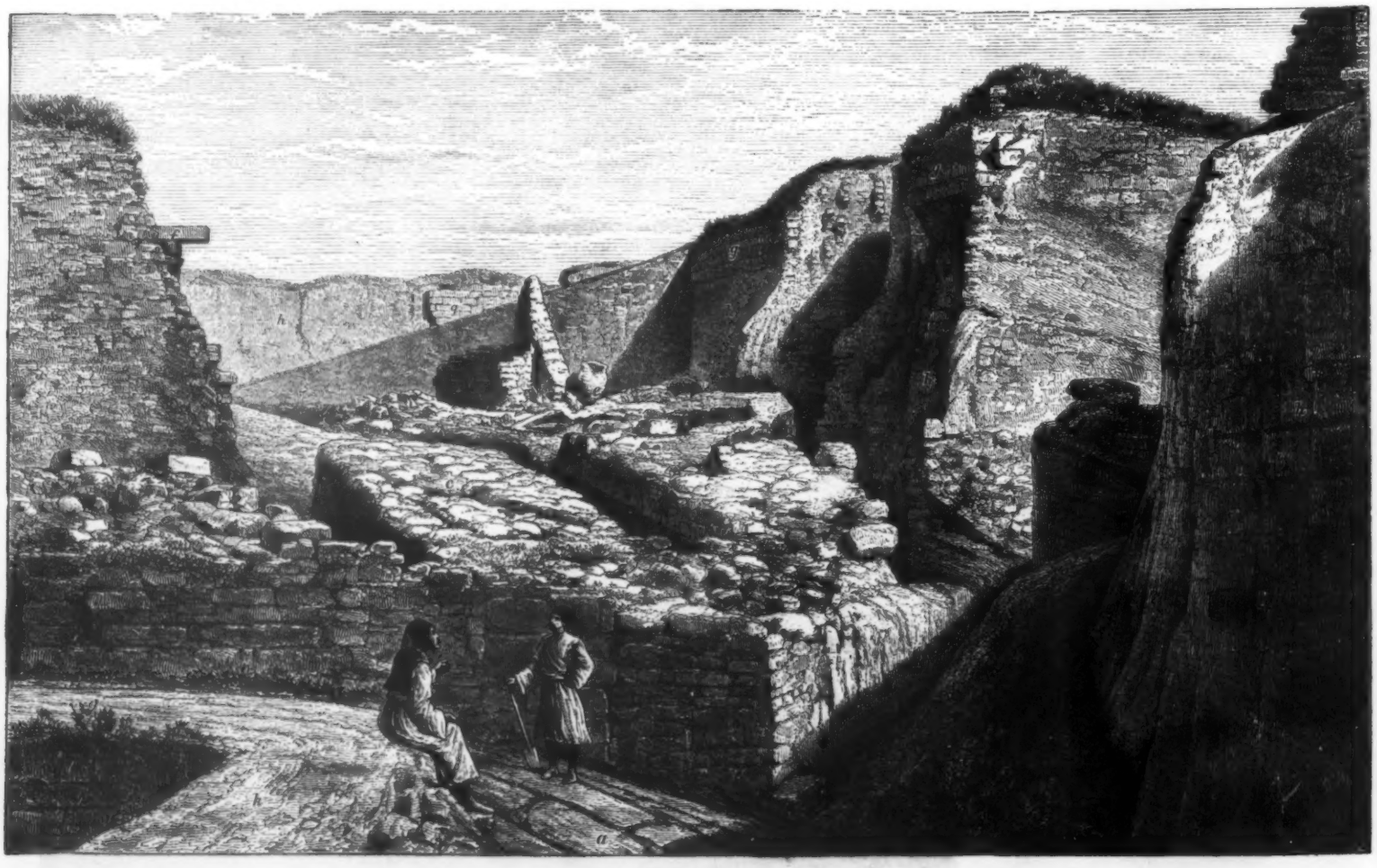
DAGGER BLADE, WITH INLAID WORK, FROM FOURTH GRAVE.

live with them at the sacrifice, in battle, in the joy of their festivals, and in their mourning for their dead; they are again flesh and blood. Schliemann's discoveries give a background of reality to our studies of the human race.

A further benefit derived from Schliemann's discoveries is that they bury forever the fiction about the originality of Greek art. We know now the sources from which it was fed, and seek, on the one hand, to find again these sources, and, on the other hand, to learn how Greek artists modified the superabundance of fantastic forms brought to them from the East to the simple, pure, and harmonious forms peculiar to their art.

As we have already stated, the effect of Schliemann's discoveries on scientific archæology is very marked, and it is, therefore, proper that we should glance at the part played by Schliemann himself in bringing this about.

THE "GREAT TREASURES" OF PRECIOUS METALS FROM HISSARLIK



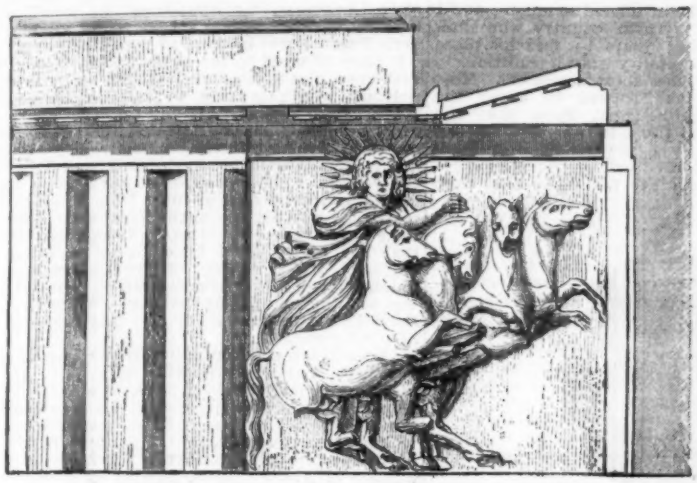
THE GREAT EXCAVATION.

(*a*. Street leading to Troy. *b* Outer wall. *c*. Inner wall. *d*. Outer projecting wall. *e*. Earthen jar. *f*. Ruins of the Temple of Athena. *g*. Greek wall. *h*. Mass of material with which the ruins were filled in. *i*. Entrance to the excavation.

First, we will refer to the promptness with which this energetic man followed the work of each excavation with a report of the same, and these reports were no dry, short synopses, they are standard works containing a surprising number of excellent illustrations, thus allowing the world of scholars and artists to enjoy with him the newly acquired knowledge. Through the friendliness of the Brockhaus publishing house, we are in a position to present illustrations chosen from some of these fine works.

We would advise every one who is interested in such subjects to read Schuchhardt's excellent work treating of the excavations at Troy, Mycena, Orchomenos, Tiryns, and Ithaca.

Schliemann's house, which always stood hospitably open to antiquarians visiting Athens, is deserted, and his wife and children mourn for him who died far from them. Every one interested in the science of the antiquarian has reason to mourn with them, for although the country of his adoption carries on his work with praiseworthy zeal, still we have lost much in losing him, for he had great plans.—*Illustrirte Zeitung.*



THE "HELIOSMETOPE," FROM THE TEMPLE OF ATHENA, AT ILIUM.

VESSEL OF SILVER AND LEAD ALLOY IN THE FORM OF A STAG, FROM THE FOURTH GRAVE AT MYCENA.

[FROM THE INDEPENDENT.]

SCHLIEMANN.

By IRVING J. MANATT, Ph.D., LL.D.

WHEN I came to Athens, I found but one of the old Greeks left—he was a native of Germany and a citizen of the United States; and to-day we have laid him to rest in the glorious company of his spiritual contemporaries and compatriots—the men of the Heroic Age of Greece.

Dr. Schliemann died at Naples on Friday evening, December 26, 1890. He had gone to Halle in November, seeking surgical relief for his growing deafness. The operation seemed every way successful; and his great friend Virchow, whom he visited a few days later at Berlin, wrote Mrs. Schliemann how well he was and what a happy Christmas they would have together on his return to Athens. He went on to Leipzig and Paris, where he devoted three days to business. On his way home he caught a severe cold, and stopped at Naples for treatment, telegraphing his family, doubtless to spare their anxiety: "Give me two days for Italy, and forgive me for not coming Christmas. Will spend one day in Naples and one at Pompeii." Then came a dispatch from the Naples innkeeper: "Your husband is very ill, and your presence necessary." But before the next steamer sailed, the end had come; at six o'clock on the evening after Christmas he breathed his last.

And so the magic spade is laid away forever, and buried cities may now sleep on; the wizard of archæology rests at last from his never-tiring toil.

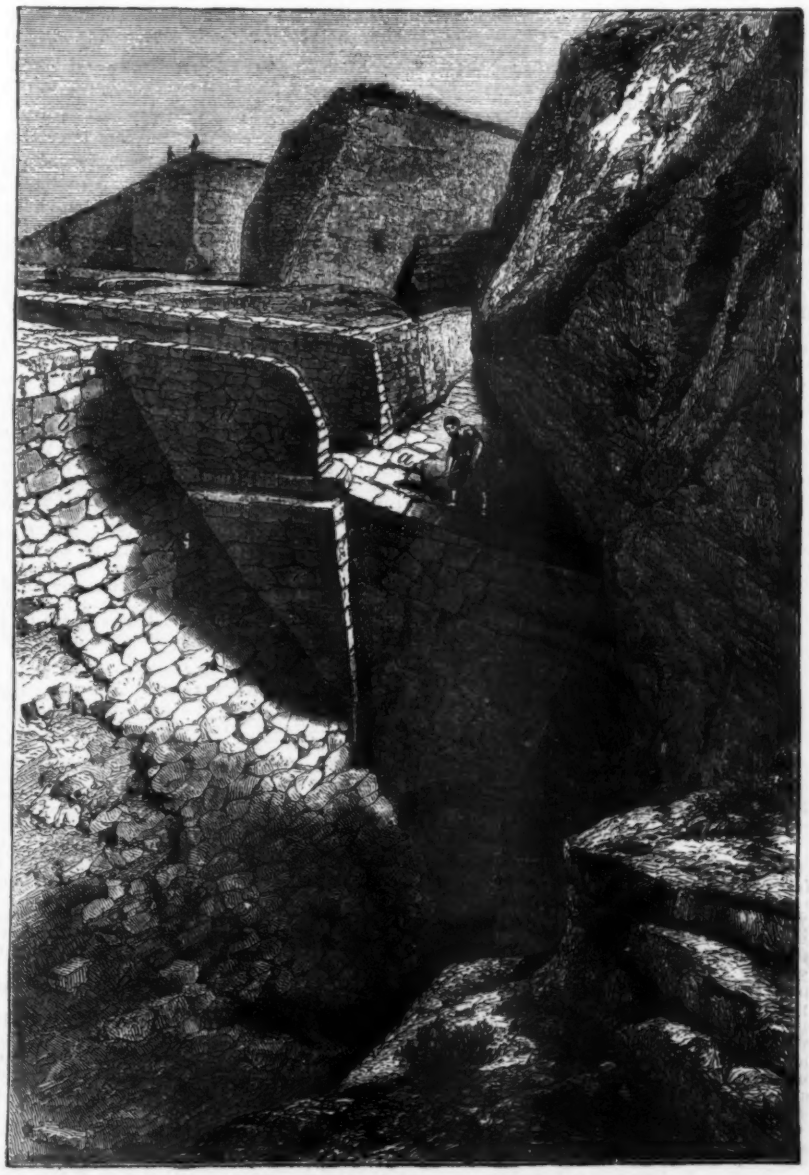
My acquaintance with him began some fifteen months ago. He was one of my first callers upon my arrival in Athens, and his house has ever since stood open to me with a genial and gracious hospitality such as a stranger land rarely offers. Moreover, it was my lot to receive the last sad news of him even before it was broken to his wife and children. Privileged to enjoy his friendship thus in the evening of his life and to share the sorrow

INTAGLIO OF A SEAL RING FROM THE FOURTH GRAVE AT MYCENA.

of his house at last, I am glad to send these lines of reminiscence to the multitudes in the land of his adoption who know his work and honor his name.

His personality was unique. German born, American by civil adoption and sympathy, Hellenic in his attitude to the heroic past, in his simplicity a very child, he was yet pre-eminently a citizen of the world. His life is so well-known from the frank and childlike autobiography prefixed to his "Ilios," that one need hardly recall here his wide wanderings among men and his sweeping conquest of human speech. An enthusiast, if not a visionary, from his cradle, at eight years old in his father's humble parsonage at Aukershagen he had settled upon the object of his life, the uncovering of ancient Troy. The battered Christmas gift of 1829, Dr. Georg Ludwig Jerrer's "Universal History," is still treasured in his splendid library in Athens, and

GOLD PENDANT FROM THE "SECOND CITY," HISSARLIK.



FOUNDATION OF THE ACROPOLIS OF THE "SECOND CITY," HISSARLIK.

in it he has pointed out to me the rude picture of Troy in flames, the sight of which first lodged the seed thought in his soul.

Myriads of boys have seen visions and dreamed dreams and stopped there. Not so little Heinrich. His will hewed a way to achievement beyond his dreams. First, there was a conquest of poverty, showing a practical sagacity and an indomitable spirit which were capital enough for the most aspiring and exclusive money getter. Then there was, concurrent and following, the conquest of ignorance; the story of his self-education is a new chapter in heroism, and the culture heroically won, far from being hidden in a napkin, was lavished on the world. No less than his hard earned wealth, it was the indispensable requisite to his great purpose. Armed with wealth and culture, both wrung from Fate, he advanced upon that purpose with a sure and steady step, and, attaining it, he linked his name inseparably with the name of Homer and the history of civilization.

A personality at once so simple and so great, so universal and yet so unique, hardly appears twice in a

UPPER PART OF A TERRA COTTA FIGURE FROM MYCENA.

generation. To meet such a man is an event, to enjoy his every-day companionship a privilege. As I knew him first he seemed a man in peril of the envy of the gods. The object of his life achieved, settled in his splendid palace in Athens, the city of his dreams—a palace fairly overflowing with the muniments of the world's honors—with wealth abundant, with troops of friends, with a charming family, one might well doubt if from Cecrops down Athens had ever held a happier citizen. Yet, withal, Athens had never known a more untiring toiler. Hours before the Attic dawn, winter and summer, daily he was at Phaleron for his plunge in the divine sea; all day long the busy work went on, and late into the night the lamp burned in the study that looks over the city upon the Acropolis. If you looked in upon him—and the door was always open—you might find him conning his Lucian or studying a new inscription or poring over the last archæological publication or directing the restoration of basketfuls of ancient vase fragments.

From any of these occupations he would turn to show you his newest treasure, or it might be a letter from some poor American professor asking his advice about bringing out a Greek play in some far western college. One day, I remember his showing me with

TERRA COTTA FIGURE FROM MYCENA.

great joy a beautiful fourth century vase just unearthed by his own workmen in excavating for a block of houses in University Street, and then suddenly, as he held the lovely toy in his hand, turning to descant upon the sadly small return he could expect from his new investment. To the last he was the alert man of business, as intense in lamenting an untimely sale of Cuban railroad stocks as in resenting Captain Boetticher's assaults on his Trojan theory.

Though retired from what men call business, his hands were full enough of that to overwhelm an ordinary business man.

With his houses in Berlin and Paris and Indianapolis, his tobacco plantations in Cuba, and his coffee plantations in Brazil, a leading stockholder in the national bank of Greece and the Piræus railway, and carrying large investments in different countries, he yet held every thread so firmly that a stranger might open his last will to-day and administer it without asking a question of any living man. That document, indeed, is as unique as any of his works, distributing an estate of fifteen millions of francs, to say nothing of more priceless treasures, with a precision and particularity which absolutely exhaust those terms. It reads, in fact, as if it might execute itself.

Yet with all this financiering and digging and building and book making (this last a large business by itself), he found time to entertain everybody, and he never missed a meeting of the Archæological Schools—German, British, or American. His interest in these schools was warm and constant, and no wreaths laid upon his bier to-day were more justly due than theirs. In no other circle can he be missed so much; and I pity the young men of my own country who shall resort to Athens in coming years to find his place vacant and his genial hospitality only a tradition.

At home he was of all men most accessible. Most of our countrymen come to Athens to climb the Acropolis and—see Dr. Schliemann. Save that the sacred rock was rooted and the man was not, the one thing was well nigh as easy as the other. How often I have seen him suspend his work to receive people with no other claim than the fact that they were

ANTHROPOMORPHIC VASE FROM THE "SECOND CITY."

Americans; and with what a nervous courtesy he would open his treasures to them and conduct them over his beautiful mansion and point out from his library balcony the profile of Gladstone, hewn by the Supreme Sculptor in the southeast declivity of the Acropolis, and even detain them when all their intuitions bade them be gone and leave the good man to his tasks.

Only a few years ago I had occasion to write him a note, asking when he could see a countryman who was rushing through—this precaution because Athens was then receiving some princely guests, and they always asked much of him. Immediately came an answer, written as usual in classical Greek, saying that he had just received the commands of the Princess ——, but that he would see what could be done and call upon me.

An hour later he appeared in full dress, to say that he was on his way to accompany the princess, and explain to her his Mycena collection at the Polytechneion, but that he would be happy to see my friend the next day.

I had to say that he was leaving early in the morning, and begged him to think no more of it. But no.

"Let your friend," he said, "come to the museum and hear my lecture to the princess. He can remain quietly near by, or I will introduce him to the princess—yes, I'll introduce him."

Of course I protested that neither my friend nor I could think of such a thing; but he insisted on my communicating his wishes. This I did; but my countryman wisely chose to waive the introduction to the princess and take as a souvenir instead the doctor's autograph note in old Greek. It has now a unique value as one of the last notes ever written by him in Athens.

There are other notes of his of which I can scarcely trust myself to speak, but here is one whose story is so perfumed with his personality that I cannot withhold it:

"I beg you," he writes, in his dear old Greek, "I

CLAY VESSEL IN THE FORM OF AN ANIMAL, FROM THE "SECOND CITY."

beg you, *with your daughter Artemis* and your wife, to breakfast with me day after to-morrow, Sunday, when the sun is in mid-heaven."

The day before, in the height of the August heats, I had taken my daughter (just then arrived in Athens) to see his Troy collection, supposing him to be, with his family, at an Austrian watering place, but to our great surprise we found him at home hard at work, with heaps of pottery and other spoils fresh from Troy. But he was not too busy to give us a warm welcome—his surprise at seeing me in Athens at that season being no less than mine at finding him.

His spontaneous sympathy with youth shone out in his welcome to my daughter. With the ruling passion in him strong, he decorated her offhand with an Homeric name and a divine one at that, Artemis—appealing to his co-laborers to say if she did not look the image of the goddess. It was enough to turn an older head than seventeen, but we had to take him seriously when he began to put it in writing. At that breakfast Artemis was installed in the place of mistress of the mansion and received the homage due to her illustrious new name. And since his death Mrs. Schliemann has shown me some of his last letters to her, from one of which I had the mournful pleasure to transcribe in his good old Greek the original of these words: "I entreat you the first time you go out doors, to call upon Mrs. Manatt. . . . . She has a beautiful daughter, *whose name is Artemis*, so Andromachidion must go with you."

The visit was made on Christmas day, and the night after Christmas, far from those he loved, the dear thoughtful soul passed to the realm wherein all his little illusions will be more at home than here.

I have alluded to his last work at Troy. When I first knew him he was much stirred up by Boetticher's polemics and preparing to resume his excavations there. He had challenged the world to stand by and give judgment. As an American citizen he took out our passports for himself, his family, and his servants, and it may as well be remembered that Troy was uncovered under the protection of our flag. I have had charming stories of him there from friends who were privileged to visit him in the midst of his work, but I have to tell rather of his return from Troy. He signalized the event by a little dinner in honor of his engineer, Major Steffen, of the German army. The guests were chiefly archæologists, of course, but there was nothing stale about the feast. When all had had their fill of meat and drink, the host rose to toast the honored guest.

I have heard many an after-dinner speech in many a tongue, but never another like that. Dr. Schliemann spoke in English—I think to accent his citizenship as well as in deference to his English-speaking guests—and in the most childlike way poured out the feeling of the moment, now of exultation as he alluded to the favorable verdict of Virchow and the Commission of Archæologists, now of exasperation as he scored Boetticher and his antagonists in general. As he grew more vehement, his language grew more labored, but the whole effort was so characteristic of the man that we cheered him to the echo.

The guest's response in exquisite German was as felicitous as anything I ever heard from any orator, but Schliemann's avalanche of honest feeling, in broken phrase, will outlast it in all our memories, and the hours that followed of delightful converse and music and general *Gemüthlichkeit*—ah! the Attic flavor of it may well outlast the speech.

The hospitality of his "Trojan hut" (so he would playfully translate his *Ἴλιον Μέλαθρον*) was unbounded. Grand balls or little dinners, it was always good to be there; but the smaller the party the better with him in it. For state occasions the mansion is superb, and the circle that gathered there was always of the *élite* of Athens, citizen and stranger, with a cosmopolite and brainy flavor. Given such a circle in such a house—a great work of art in itself, with its fine mosaics and its rich frescoes and its Odyssean verses speaking from every panel—and all this in Athens and under the shadow of the Acropolis, who would call it dull? And how simply and easily the honors were done. There was no strain and nothing forgotten. There, if anywhere among the moderns, the guest felt a lingering Epic flavor; there "when they had put from them the desire of meat and drink, they minded them of other things, even of the song and dance; for these are the crown of the feast." It was not only that this was Athens with all the enduring monuments of Hellenic glory round about you; or that the very objects familiar to the Homeric man fairly overflowed the mansion; or that sculptured gods and heroes guarded its battlements; or that Homer in lustrous Parian looked down upon you from the great mantel and his immortal lines spoke to you from the walls, and half the mythology of old Greece hovered about the vaulted ceiling. More than all that the household itself was Homeric.

Among his busy servitors were Æneas and Creusa; Bellerophon was his porter, and Priam kept his garden; Circe and Electra were his handmaids. No matter what name one brought into his service, the chrism of the Hall of Troy made all heroic. His own children were Andromache and Agamemnon from their birth—for short Andromachidion and Agamemnonidion. Why his pure Greek wife Sophia was not rechristened Athena I could never quite make out; probably the reason was purely legal. His tenderness for her spoke even in the address of his last post card—Sophidion Schliemann.

For himself there was little need of an Homeric name, though one wonders how he could have curbed his ruling passion to adopt one; there was the bright example of Melanchthon and so many worthies of the reformation era. But, like Luther, he did well to make a humble name illustrious instead. He was too Homeric in himself, in the fiber of his being, to wear a borrowed robe.

From the day he looked upon the rude picture of burning Troy in his father's lowly parsonage, he knew his mission. From the moment when, apprenticed to retail molasses over a village counter, he heard a drunken *Bursche* spouting Homer and spent his last *groschen* for a glass of whisky as an *encore*, the passion of his soul was constant. He had to wait, indeed; to dig up Troy was a task, he knew, that wealth alone could compass, and to wealth for Troy's sake he hewed his way through the very fastnesses of Fate.

That goal reached at thirty-six, he sat down like any little child to learn his *alpha beta* and master the mighty epics in the tongue divine. Henceforth (to quote the *Acropolis*) "Homer was his gospel. He never lay down to sleep without reading some Homeric verses. It was his evening prayer. And even at table his servant would read aloud to him from the Master, until in his enthusiasm he would cry: 'Hear the music! hear the music!' The lines of Homer were his orchestra."

In this connection I recall the last visit he made me before he left Athens to go to Halle. We had another visitor at the moment, a Greek, of Ithaca, studying at the University, and about to take his doctor examination on Homer. Of course he knew the great epics well nigh by heart. To Dr. Schliemann I introduced him as a countryman of Odysseus, and the picnic that followed I can never forget.

Like an old rhapsode Schliemann began rolling off the stately lines of the Odyssey; it was Odysseus' appeal to Nausicaa in the Sixth Book, and the shifty old

suppliant himself could hardly have put more pathos in it.

Then our Ithacan responded for Nausicaa, of the white arms. And so, like strophe and antistrophe in an old Greek play, the declamation went on at a thundering rate, until both were out of breath. The eager excitement on both sides was like that of a hot debate; but the old German held his ground well against the Ithacan, who knew nothing but Homer.

How vividly that rhapsodic hour comes back to me now that we have just buried him, obedient to his wish, with his beloved Homer on his breast.

I think he must have realized the world of Homer even as a little child lives in fairyland. When the first skeleton came to light in the Royal Tombs at Mycena, he fell upon his knees before it, exclaiming, "Thus have I imagined my hero." No wonder his naive faith hastened to accept the King of Men, while the incredulous waited for credentials which can never be forthcoming.

He went to Mycena to find Agamemnon, and he found him; he went to Troy to uncover Priam's citadel, and he uncovered it, even though the centuries had piled city upon city on its ruins. The child is never much surprised by anything it may find in the Christmas stocking. I doubt if Schliemann was ever really surprised by what he found at Mycena and Troy. The surprise was rather when he found nothing, as in Ithaca. The great joy of his discovery no man could have felt more; but in his mind he had lived so long and so thoroughly in the Heroic Age that he must have felt quite at home when he broke into its actual presence at last. And to-day, in the Elysian Fields, I think he may be greeting Homer as he greeted the heroic dust at Mycena: "Even so have I imagined my poet." Only the poet will not be dumb; but after the nectar and ambrosia there will be winged words and song to crown the feast. Socrates could smile at death in the prospect of meeting at the journey's end Orpheus and Musæus and Hesiod and Homer, and continuing in that celestial company his eternal quiz. Schliemann's spade cannot enter there, but I am mistaken if Homer and all the heroic shades do not welcome him to their august society. For the immortals are not ungrateful, and they know their kind.

Until the will was opened, we thought he was to rest with Lenormant and Otfried Mueller on Colonus; but such was not his choice. In the early afternoon of this Sabbath day we gathered about his bier in the grand *salon* of the mansion, while all Athens seemed to throng the street without. The honors of the world were piled upon that pall; the highest decorations from the world's great rulers, from imperial capitals, from learned societies—these, the recognitions accorded to him in his life; while crowns and condolences came, now that he was dead, from his young Kaiser, from the imperial city of Berlin, which had bestowed upon him a distinction shared only by the great chancellor and the great field marshal—that of *Ehrenburger*—and from learned men and learned bodies without number. And at the casket's foot stood the King and Crown Prince of Greece, generously oblivious of the fact that years ago he had declined their royal decorations.

In the presence of all this homage how pathetic the story of his life! Fifty years ago, shipwrecked and penniless, he had entered Amsterdam. "Winter had set in, I had no coat and was suffering cruelly from the cold. As my means were entirely exhausted, I feigned illness and was taken into the hospital." Yet hear him in the moment of his deliverance, after nine hours tossing on the deep in an open boat: "I felt as if on that bank a voice whispered to me that the tide in my earthly affairs had come and that I had to take it at its flood." And even so it was, and taken at its flood that tide had led him on to fortune and to fame. The keynote of his life, it was well said, had been faith; by faith he achieved wealth, by faith he made conquest of great provinces of learning, by faith he so entered into the heart of Homer as to know that Troy was, and Mycena and Tiryns, and to make all men see them.

And now he is at rest. "At the highest point of the Hellenic Cemetery," on this lonely Sabbath day as the westering sun gilded the Parthenon and brightened the snowy range of Parnes and the divine sea and Salamis, for all these sentinel his resting place, we gave him "earth to earth." And so, Heinrich Schliemann, child of poverty and struggle, youth of strenuous aspiration, man of achievement beyond thy dreams, dauntless as Achilles, many sided as Odysseus, Greek of heroic Greece, though born out of time and place, hail and farewell.

Athens, Greece.

[Continued from SUPPLEMENT, No. 790, page 12626.]

AN ASTRONOMER'S IMAGINARY VISIT TO VENUS.

How shall I describe my emotions when, after a long voyage, during which we had seen the sun rise from near the horizon to an elevation of some 25 or 30 deg. and the temperature had changed from extreme cold to great warmth, we arrived in a noble bay, and I beheld in the distance the swelling domes and gilded minarets of a great and rich city? The bay was crowded with vessels, and our arrival was the signal for a demonstration in our honor. The commander had informed me that this was the capital of his country and a very populous and busy town. Even before we had landed I was amazed at the beauty and magnificence of its architecture. It seemed to me to combine the superb situation of Constantinople, the strange splendor of Moscow, and the commercial advantages and busy look of New York, with a display of daring and splendid architectural conceptions that at once astonished and captivated the beholder. Magnificent systems of railroad communication, elaborate and thriving industries, and the most ingenious and wonderful applications of electricity in the transmission of power had, as I soon learned, laid the foundation of all this prosperity.

The report of the finding or capture of two strange men, one of whom was an inhabitant of that mysterious dark hemisphere which seemed forever shut off from communication with the lands of light by an insurmountable barrier of ice, while the other pretended to have come from a star, spread on the wings of the wind, and we became the lions of the hour. The chief officers of the government, the leading scientific men, distinguished visitors from other countries, and citizens of every rank and occupation thronged to see us. We were turned over to the care of the great central scientific body of the nation, corresponding to our Association for the Advancement of Science, and became at once the focus of attention for all the philologists, anthropologists, ethnologists, geologists, geographers, archæologists, and theorizers of every description. The fact that I had learned their language placed me at once on most agreeable terms with these erudite men, who informed me of many interesting particulars concerning their planet. From the chemist I learned that the atmosphere of Venus, while resembling ours in the formation of clouds and the precipitation of rain, as well as in its life-supporting properties, yet varied from it in diathermancy, so that the planet's surface was to a great degree protected from the fierce gush of heat continually poured down upon it by a sun which never set. . . .

If there is anywhere a planet that deserves to be called the world of flowers, it is Venus. They abounded in the town as well as in the country. There were hundreds of varieties of flowering trees, whose great round tops were masses of the most exquisite colors. The air was redolent with delicious odors. Every house in the city had its flower garden, and half of the buildings were almost concealed under climbing plants that were ablaze with blossoms. Magnificent arches of living flowers spanned the streets in a thousand places.

The difference of opinion in regard to me soon became a dispute, and in a short time a controversy that divided the capital and ultimately the state. Indeed, it was not long before learned representatives of several nations had met to cross-examine me and discuss my extraordinary story. Yet I am happy to say, so great was the natural courtesy of these people, I was never subjected to any rudeness or personal indignity. They treated me with every appearance of the highest respect.

Finally the matter was referred to the Supreme Conclave of the Pure Mathematicians, a body of savants that possessed the highest influence among the Apodi—that was the name of these people as I made it out. I was summoned before the conclave and requested to present proofs that I had come, as I said, from another planet called the earth. The president was careful to assure me that it gave him and all his learned associates great pain to have to appear as questioning the word of a gentleman, but I must remember that this was a matter of the highest scientific interest, and they would be derelict did they not provide for the information and satisfaction of posterity irrefragible evidence of the truth of my story. I then repeated what I had told the commander of the vessel about the sun spots, and added various proofs that I possessed information which I could hardly have obtained if I had not lived upon some other planet than Venus. I unfolded our whole system of astronomical knowledge, and the wrapt attention of my hearers was evidence of their interest. Among other things I told them that the earth was accompanied by a satellite called the moon, and described the comparative size of the two orbs, and their distance apart, and the period of the moon's revolution. Then I made a rough sketch of the earth's surface, representing as much of the outlines of the continents and seas, including the white polar snows, as I judged would be visible from Venus, and concluded my address with these words:

"And now, gentlemen, I will, under your supervision, direct the great telescope of your solar observatory to that point in the sky where my knowledge of the solar system enables me to assert that the earth is at present, and you shall see that what I have told you of that planet and its satellite is true."

This proposition made the greatest sensation I had yet produced. It was, of course, accepted at once, and the experiment I had suggested was tried without delay.

They found everything as represented. They watched the changes in the place of the moon as it revolved about the earth, they saw the faint shadows of the continents and oceans appear and disappear and succeed one another as the earth rotated on its axis, and in the transport begotten by these extraordinary discoveries they almost forgot the great question that they had been called upon to decide. The ingenious jewelers of the town, catching the popular enthusiasm, turned out thousands of little golden spheres beautifully enameled with the principal features of the earth, which found a ready sale, largely among the women, who hung them at their throats, and in their eyes I became a greater hero than ever.

I was myself obliged, at length, to recall the learned matematicians to their task, as I was anxious to have the question settled. They assembled accordingly in secret session, all the proofs and arguments on both sides having been submitted. Their decision was announced at a public session in the great hall of the national university.

They filed into the crowded room, wearing their formal dress like the judges of a court, and when silence was restored, the president announced the result of their deliberations.

"We find," said he, "in accordance with the laws of the mathematical doctrine of probabilities, that the chances in favor of the proposition that an inhabitant of another planet could come to Venus are only as 1 to 1,000,000,000,000,000,000."

My hopes fell at these words, and there was a murmur of disappointment in the audience. "But," continued the president, "we also find that the chances in favor of the proposition that our learned guest and visitor could not have obtained the astonishing information which he has given us if he were only an inhabitant of our planet are as 1 to 999,999,999,999,999,999. Wherefore we give our decision for the truth of his account."

A roar of applause, broken with shouts, cries, and cheers, followed this announcement. The whole audience rose to its feet in the greatest excitement. I was seized by a band of young men and borne aloft through the streets, which were crowded with people who yelled and cheered themselves hoarse, while white apparel was waved from every window and we were showered with flowers.

In the course of time the excitement died out, and first the populace, next the savants, lost interest in Jupi and me.

In the meantime I determined to carry out a design of my own that had been running in my mind for a long while. I had learned in my conversations with the Apodi what I had before suspected from *a priori* reasoning, as well as from the telescopic appearance of the planet as seen from the earth, that toward the east, in the central region of this hemisphere, where the perpendicular rays of the never-setting sun produced, notwithstanding the remarkable lack of diathermancy of Venus' atmosphere, a torrid heat, too fierce for living creatures to bear, there existed a great expanse of country, many thousands of miles across, which was continually buried in clouds. This torrid region was circular, and all around it extended the comparatively narrow temperate zone of the planet in which the Apodi and the other peoples of Venus dwelt. But between the torrid circle and the temperate zone they assured me raged a belt of storms where the ground was drenched with scalding rains, and frightful whirlwinds and awful electrical tempests appeared to devour the very globe, so that no man could pass through them and live.

I wished to see these things for myself. To assist the reader, I give here two little charts of Venus, as I found it, which will do more than a page of words in explaining the situation of the various lands that I visited.

THE DARK AND LIGHT HEMISPHERES.

The shaded part is where the sun, or a part of it, is seen during half of the year. The ice mountains were found near the dark border of this region.

BIRD'S EYE VIEW OF THE ENLIGHTENED HEMISPHERE.

I was not deceived in the character of the region which I now visited. Long before I reached the border land of storms violent atmospheric disturbances fretted the surface of the planet. The heat and glare, as the sun rose higher, with my advance, became terrific.

Venus' distance from the sun is to the earth's distance from the sun in the ratio of 67 to 93. In order to compare the light and heat received by the two planets, we must square these numbers, remembering that light and heat vary in intensity inversely as the square of the distance. Thus it appears that the solar radiation on Venus is almost exactly twice as intense as it is upon the earth. But then the earth, by daily rotating on its axis, is relieved for half the time from the downpour of solar heat. The illuminated hemisphere of Venus, on the contrary, is constantly exposed to the sun, the effects of whose heat are thus accumulated to a frightful degree. We have an example of similar accumulation on the earth in the well known fact that the greatest heat of summer is not felt until about six weeks after the solstice, or after the sun has reached its furthest northern limit and advanced well on its way back to the equator. I have spoken once or twice of the fact that on Venus the atmosphere was unusually impervious to the solar heat, possessing apparently the property either of reflecting a large part of it back into space or of radiating it away with great rapidity. But for this fact the thermal accumulation would no doubt have been sufficient to render every part of the enlightened hemisphere utterly uninhabitable except close to the border line between light and darkness, where the neighboring deposits of snow and ice would tend to keep down the temperature. Yet this athermancy of the air did not avail to protect the planet from excessive heat nearer the center of the sunward hemisphere, where the solar rays fell less obliquely. Indeed, I imagined from the effects I perceived that the atmosphere became more diathermanous in proportion as the incidence of the rays approached perpendicularity, and that the quantity of heat received became greater per unit of surface.

As I drew nearer the torrid circle a great wind arose, blowing always in my face, but afterward the wind changed and blew me on my way. Then the sky became suddenly as black as midnight. A heavy roaring shook the ground. Presently the sky lightened a little and immediately an awful cloud appeared, as dark as Erebus, its perpendicular front towering, it seemed, to the very apex of the firmament, where it was crowned with a lurid flame. Slowly and majestically it moved forward, and blinding flashes of lightning began to play from its sides. As it advanced, the landscape at its feet was swallowed up in impenetrable darkness. My heart quaked. I would have fled, but terror held me fast.

In a few minutes huge drops of hot rain began to patter, and then I was caught up by the whirlwind, tossed among the clouds, and finally deposited on the

steaming ground uninjured. As I struggled to my feet a hissing rain began to fall in sheets and torrents, and almost bore me down with its weight. Wicked gleams of lightning pierced the curtain of rain on every side, and the short, sharp cracking of the thunder was heard every second In a little while another change occurred. The heavens cleared as if by magic, and the deep blue sky was flecked with high fleecy clouds, through which the sun beat down with scorching rays.

This lasted but a short time, and then I beheld two portentous storm clouds rushing together from opposite quarters, and the roar of the contending elements was resumed with tenfold greater fury than before.

Hot rain gushed down again in torrents. Then a hundred tornadoes seemed to have met in one. The heavens were filled with spinning clouds, whose ceaseless gyrations conveyed to my dizzied brain the impression of a firmament crowded with wheels, which whirled faster and faster and ever faster until I lost consciousness. When I opened my eyes I lay on my back, and for a moment fancy persuaded me that I was in a Russian vapor bath. I could see but a few feet through the steam-choked air, and respiration was very difficult. Another quick change swept off the vapor, and the sun smote me with temporary blindness. Then the roar of the winds began again.

It is impossible for me to tell how I got through the realm of tempests, but finally I reached a place where nature seemed at peace. The scene was a marvelous one.

The sky was completely overcast with dense clouds, through which the diffused light of the almost perpendicular sun was hardly able to force its way. This heavy cloud stratum served to protect the planet from the solar fury, and it was evident that a large part of the water which would otherwise have swelled the lakes and seas beneath was suspended high in the atmosphere. Yet these clouds which shielded off the direct rays of the sun acted also as a blanket to retain much of the heat that had penetrated beneath them, so that the climate was overpoweringly warm and moist.

The atmosphere was charged with vapors that almost stifled me. Such a spectacle as was spread before my eyes no mortal ever beheld outside the "ideal landscapes" of the geologists. It reminded me of the pictures I had seen of the carboniferous and reptilian ages of the earth. Gigantic palms and ferns, almost a hundred feet in height, towered up from the swampy soil, and I was surrounded by strange vegetation, wonderful in its forms, amazing in its profusion.

Presently I came upon some of the animal life of this extraordinary region—gigantic centipedes, monstrous batrachians, chelonians of the sea and of the land, and terrible saurians, both flying and crawling. The scenes that were enacted beneath that mighty canopy of clouds beggar description. Here was the struggle for existence, in all its horrible reality, carried on by beings that seemed fitted only to destroy each other. It was a frightful world that I had ventured into, and I could see no prospect that it would ever be any better, for supposing all the water of the planet to be taken away and the shield of clouds withdrawn, then the sun would pour down so fierce and devouring a heat upon the naked land that it would be changed into a fiery desert. Yet even here the form that on the earth we call human had its representative, and a terrible representative it was. While I stood watching a mighty beast, not unlike the enormous lizard of Jurassic time which Mr. Marsh has named the atlantosaurus, tearing the leaves from a lofty palm, I was startled beyond measure to see a gigantic ape-like animal spring from concealment, and, armed with a huge club, attack the saurian. I have described the agressor as resembling an ape in form, but he was also manlike in many of his characteristics, and this fact added greatly to the sympathetic interest with which I viewed the struggle. If I call him an ape, the reader will understand that I do so only for the lack of a more descriptive title, and because I do not wish to bestow a higher name upon a creature which proved itself so fierce and terrible. The great ape approached its big antagonist without the slightest hesitation, and with a quick, swift swing brought the club down upon its extended back. There was a crack like the noise of a breaking beam, and for the moment I thought the beast's back was broken. It had been taken unawares as it was reaching for the leaves, and the blow felled it sidewise, so that it lay struggling at its length on the ground, its belly exposed and its huge limbs sprawled in the air. But in an instant it regained its feet and turned on its foe with a fearful snarling cry that made my flesh creep. Its expanded jaws seemed to me two yards wide, and their red sides were armed with teeth capable of crushing a buffalo.

But the ape did not give an inch. I could see the gleam of his tight-shut teeth as he drew back his club for a second blow, and I felt that this blow would settle the contest one way or the other. As the saurian reached for him he stepped a little aside with a movement as quick as thought, and down came the terrible club across the huge head, which, with all its armor of scales, it crushed in like an egg shell. That ended the battle, and while the monster was in its death throes, the ape set up the most fearful shrieking that ever split my ears. This proved to be merely a call, for in a few minutes three other creatures of its kind came running up, and began inspecting the slain saurian, chattering meanwhile in loud, discordant tones. A glance at the huge hand shaped prints made by their feet in the mud, recalling my geological studies, caused me involuntarily to exclaim "cheirotherium."

And indeed I thought my eyes really beheld that beast only known to science by its footprints found in certain sandstones.

My voice reached the alert ears of the apes, and turning, they all saw me at once. Seeing was doing with them, and, with simultaneous bounds, they were upon me. Whereupon I quit the planet. G. P. S.

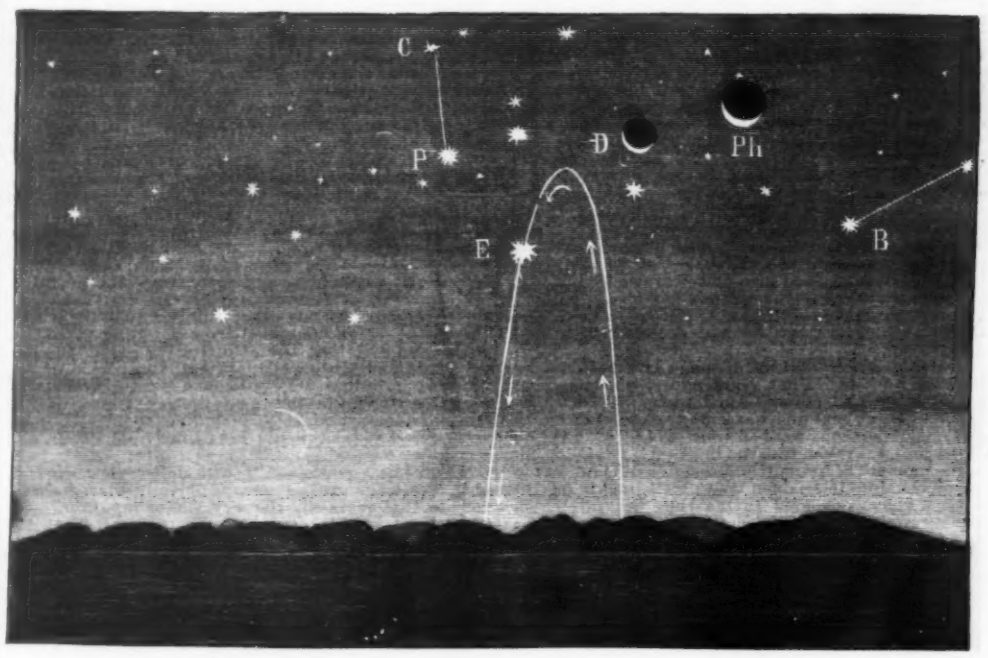
IT is proposed using the Eiffel Tower to exhibit the rotation of the earth by the Foucault method. The pendulum is a bronze wire 380 feet long, with a steel globe at the end, weighing 198 pounds,

THE EARTH AS THE MORNING STAR OF MARS.

MORE than a hundred years ago the celebrated German philosopher Herder first gave utterance to the thought that the earth was only a "star among stars." Few of the scientific theologians of the time would tolerate the idea. They thought of the stars as servants and messengers to the earth, the real "creation," and considered it humiliating to have it ranked with the army of stars. But science has fought bravely against the prejudice of ages, and conquered. Practical astronomy has placed us in a position, not only to confirm Herder's statement, but also to know how our earth appears as a "star among stars."

The accompanying cut illustrates the role played by the earth as morning star of Mars, to which it appears as a star of the first magnitude, bearing the twins Castor and Pollux company and followed alternaetly by the two moons of Mars. During the whole autumn of 1890 it adorned the east-southeast heaven of Mars. For our picture we have chosen dawn between the 5th and 15th of October last, the point of observation on the surface of Mars being a certain part of the "Nile Canal" (350° longitude west and 30° latitude north). On the northern hemisphere of Mars it was late autumn, and the sun was rising in the east-southeast heaven. On the day in question its course ran 20° below the equator of Mars. It did not enter the winter solstice until Nov. 11.

From the point mentioned our earth was also seen in southern declination, its right ascension being 32½° (calculated from the vernal equinox of Mars). From this point the earth is seen below the "Twins" and also below the two moons of Mars. The earth looks about as large as Jupiter seems from the earth, covering about 40 seconds. To us, inhabitants of the earth, it seems strange that our great sphere can only be a beautiful red morning star to the inhabitants of Mars, a charming ornament of the heavens, all her inconsistencies and harmonies, her misery and her splendor, her deserts and gardens, her palaces and hospitals, her churches and her jails, her temples and homes of vice, lost sight of, all included in two words, "Morning Star." It is as if the earth had no individual existence, no history, no aims of its own.



THE EARTH AS THE MORNING STAR OF MARS.

The earth acts not only as a morning star for Mars, but also as evening star. For him she plays the same role that Venus plays for us. Like her, the earth does not move far away from the sun, never passes the meridian at night, and never presents a completely lighted disk in the telescope. It is more than probable that the inhabitants of Mars have no knowledge of her surface, at least not such knowledge as we have of the surface of Mars. The half ellipse shown in cut represents half of the orbit of the earth projected on the morning sky of Mars. When the sun culminates the entire ellipse will be above the horizon in a horizontal position. When Mars was in opposition (May 27, 1890), the earth was not visible from Mars, because she stood between him and the sun. From that time she moved away from the sun in the direction indicated by the arrows in the engraving. Toward the end of July the earth reached the outer end of the ellipse, or the greatest eastern elongation; then she was on the opposite part of the orbit from that shown in the engraving. She moves downward, so that she will pass behind the sun at the beginning of the summer of 1891, which is equivalent to saying that to us Mars will appear to pass behind the sun at the same time, and the two worlds will be invisible to one another until September, 1891. Of course the constellations in the heavens of Mars move constantly toward the west, so that the earth, which moves slowly toward the east, is constantly entering new constellations (the crab, lion, etc.) The central group of stars shown in our engraving belongs to the Twins, while those at the left belong to the Lynx and Great Bear, and those at the right to Orion, including the brilliant Betelgeuse and Bellatrix.

The two moons of Mars, Phobos and Deimos, are interesting and unique. They are very small bodies, about six miles in diameter, and revolve about Mars in elliptical orbits, the planes of which deviate very little from the plane of the equator of Mars. Phobos, which is nearer to Mars, revolves around the planet in 7 hours and 39 minutes, while Deimos requires 30 hours and 17 minutes to complete its revolution. In the first satellite we have the only existing example of a heavenly body which revolves around its principal in less time than the latter requires to revolve on its axis. This velocity of movement brings the two satellites into peculiar relations. Phobos rises in the west and sets in the east twice in one day, and Deimos rises in the east and sets in the west, but moves so slowly that it remains two days and one night above the horizon, and is absent for the same length of time. A simple calculation shows this effect is caused by the rotation of Mars on its axis. Many combinations of the earth, Phobos, and Deimos are formed, and there are, of course, frequent occultations. In our engraving Deimos is moving from the earth, and Phobos, on the other hand, is hastening toward her, and in two hours will overtake her, its crescent form shining above her, while Deimos, which has turned its back upon the earth, will increase until it appears five days later near the earth in the eastern sky, as a new moon.—*Illustrirte Zeitung.*

BATHYPELAGIC FISHERY.

THE reader will be kind enough to pardon me for the above neologism in consideration of the length of the paraphrase that it replaces; it will serve, in fact, to designate fishing with a fine net in the open sea at all depths, but always at a distance from the bottom and the surface.

The idea of endeavoring to ascertain what minute or delicate animal forms live in such situations is of very recent origin, and the apparatus used is still in the first period of its existence. It is necessary to mention, among the latter: the trawls that Asper and Imhoff used in the Swiss lakes, and that revealed to them the daily vertical migration of the copepods; then Petersen & Chun's trawl, constructed upon a principle that had already been applied by Negretti & Zambra, and the first idea of which is due (as far as I know) to Lieutenant Sigsbee; and, finally, the curtain trawl of the Prince of Monaco, and my double-door trawl that I shall describe further along. To this already long list I may add also my last invention, that of tilting trawls, which I lower, several at once, on the same cable.

All these apparatus appeal only to the most elementary mechanical principles. The inventors have designedly avoided all air pressure or electric mechanisms, which, adding their irregularities to the difficulties of operation in the sea, have never given anything but disappointment.

These objections have not dismayed Dr. Viguier, and the instrument of which he has given us a project sets at defiance several physical and mechanical difficulties. So we see Dr. Regnard's compensating balloon make its appearance again, an apparatus that cannot, in our opinion, render all the services required of it. Let us calculate a little, please. Let us say that the air spaces in the electric apparatus gauge but 60 cubic inches in all. Dr. Viguier assures us that his trawl would operate as well at 26,000 feet as at 30. Well, the supply of air necessary to make 60 cubic inches at 800 atmospheres is approximately 24,000 cubic inches. We need then a rubber balloon of 24,000 cubic inches capacity, and, in order to immerse this, it is necessary to load it with a weight of at least 1,700 pounds. The stress at the moment of immersion is exerted upon but a small portion of the bottom of the bag, and we should therefore require sheet rubber stronger than the steel plates of a high pressure boiler. The invention is applicable to slight depths only.

The Prince of Monaco's curtain trawl is made to slide along a cable whose extremity, provided with a weighty stop, has previously been lowered to the desired depth. After the fishing is finished, a traveler is slid down the cable, and this causes the curtain to close. I was employing this contrivance at the same time, without being aware of his Highness' experiments; only the two impacts, instead of causing a curtain to roll up and unroll, are utilized by me for causing one door to open and the other to close. Priority belongs to him who first publishes, but I desire to point out the independence of my experiments.

Last spring, on board of the Amphiaster, the prince's apparatus and my own were both used at various depths, up to 3,000 feet, and both operated well. Neither was on its first trial, and it will be remarked that

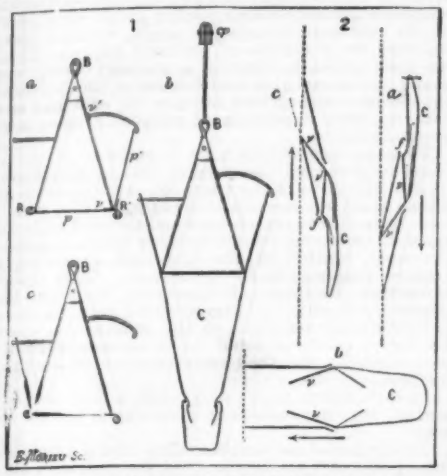
the mechanism of both is of a nature to work equally well at any depth whatever.

The curtain trawl is handsomer and less cumbersome, but, in order that it shall work well, it must be constructed by a manufacturer of instruments of precision and be maneuvered by a person used to the management of such instruments. The cost, too, is that of an instrument of precision.

The trawl with two doors is stronger. A skillful locksmith or a shop in which coarse mechanical work is done can construct it; whence it results that the cost of it is moderate and that it can be confided to the hands of members of the crew. But it is heavy, and takes up much space. I believe it well worthy of recommendation for expeditions made by governments with the aid of a ship of war and its crew.

The following is a description of my apparatus (Figs. 1 to 4):

A rectangular iron frame, 20 × 30 inches, serves as a



FIGS. 1 AND 2.—DEEP-SEA FISHING APPARATUS.

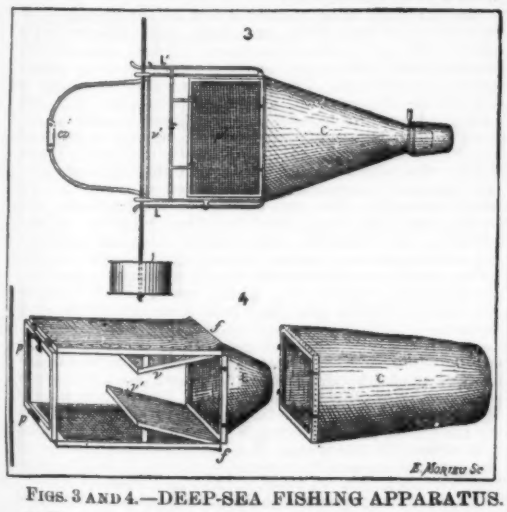
1. The three positions of the doors in Fol's trawl.
2. The three positions of Fol's tilting trawl.

support to a trawl, C, made of Zurich gauze. The mouth of the frame may be closed by one or the other of two doors, *p* and *p'*, which are fixed by hinge hooks to the long sides of the frame, and which measure, like the latter, 20 × 30 inches.

The frame is connected by iron triangles with the eyes, B, through which the steel wire cable passes. These triangles are arranged in such a way as not to interfere with the play of the doors, and serve as supports to the levers of the bolts which keep the doors in the starting position. Strong springs tend to open the door, *p* (Fig. 1, *a* R), and to close the door, *p'* (*ibid.* R'). The door, *p*, is kept closed by the bolt, *v* (Fig. 1, *a*), and *p'* is kept open by the bolt, *v'*.

The eyes, B, into which the cable is introduced, are each formed of two hooks turned in opposite directions. These slide upon one another by hard friction and are arrested in the position of closing by a small catch. These eyes advantageously replace all the uselessly complicated systems that have been employed for the same purpose.

The apparatus is freed and descends along the cable until it reaches the stop. The impact is participated in by the lever, L (Figs. 1 and 3), and throws back the bolt, V. The door, *p*, opens, and the boat being set in motion at the speed of half a knot, the apparatus



FIGS. 3 AND 4.—DEEP-SEA FISHING APPARATUS.

3. The two-pointed trawl at the moment of its descent.
4. The tilting trawl taken apart.

fishes without the cable being sensibly displaced from the vertical, provided that the stop be sufficiently heavy. When the capture is judged to be sufficient, there is slid down the cable a four-pound traveler (provided with a closing system as simple as the eyes). This traveler comes into contact with the lever, L' (Fig. 3), which unfastens the bolt, *v'*. The door, *p'*, being no longer held back, closes, and the trawl can be raised with the cable.

The two doors, open during the trawling (Fig. 1, *b*), form a sort of funnel which widens the entrance. When closed they enter a recess in the frame, rendering the closing perfect. The apparatus cannot operate badly without a notification of it being given by the position of the doors at the moment that it is drawn up.

Finally, the length of the iron triangles places the silk gauze trawl net at a sufficient distance from the metallic cable to prevent the fabric from rubbing against the cable on descending, and thus having holes worn in it.

The apparatus operates with great regularity, provided that the irons and rivetings are strong enough to prevent flexions and torsions. In this regard, I had trouble at the start, and was obliged to strengthen all the corners with angle irons. It became necessary, too, to give the springs that close the door sufficient strength to easily overcome the resistance of the water. Finally, the throwing of the bolts is not perfectly assured unless the apparatus is vertical, and, in order to secure verticality, it became necessary to add a lever carrying a plummet, *c p*, which forms a counterpoise to the iron frame.

Let us take either of these trawls (both are recommendable in different respects), and we shall always have the inconvenience of being able to fish only at a single depth determined at each operation. Now extreme depths yield but little, the animals can be found only at certain levels, and it is of considerable interest to be able to first make an exploration (by means of small trawls) of a series of different levels, in order to ascertain the depth to which the large trawl must be lowered with the best chance of success.

After many tentatives, I have adopted the arrangement shown in Fig. 4, and which will seem odd at first sight. I beg the reader not to condemn it before trying it, for it fulfills its object. This is its great merit, and wherein it differs from the finest projects. It consists of four hardwood frames. Two of these are square and of 12 in. section. The other two are oblong, measuring 12×24 in. All are connected by hinges, as shown

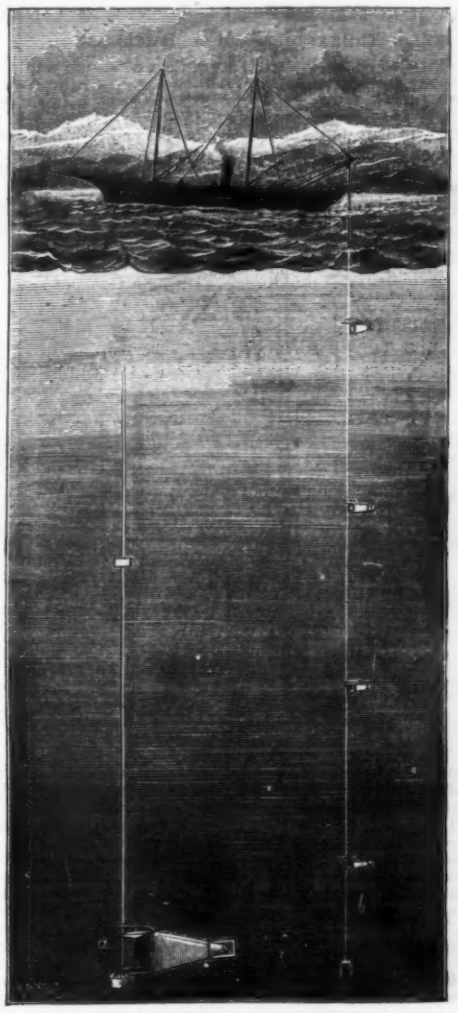


FIG. 5.—FOL'S DEEP-SEA FISHING APPARATUS IN OPERATION.

in Fig. 4. The small frames remain open, while the large ones have linen stretched over them, and are provided with supplementary frames *v* and *v'*. These latter are fixed to the long frames in an unchangeable position, at an angle of 14°. They, too, have linen stretched over them, and perform the role of shutters for closing the trawl. One of the small square frames is fixed to the cable, and to this effect is provided with clamps designed for the purpose. The other carries a truncated cone of gauze, E, and eyes that serve to hold a third frame of the same size, which carries the trawl. A 60 or 100 pound weight is sent to the extremity of a small steel wire cable. Then, while the latter is paying out, and, so to speak, without stopping, the trawls are successively fixed to it at intervals. The resistance of the water, acting upon the linen stretched over the long frames, forces the apparatus, during the descent, to take the arrangement shown in Fig. 5 (*a*), in which the mouth of the trawl is closed by one of the shutters, *v*. After the desired length of cable has been paid out, a forward advance is made at the rate of half a knot. The apparatus take the position shown in Fig. 5 (*b*), and that, too, not by virtue of complicated mechanisms liable to get out of order, but spontaneously and by the sole fact of the horizontal displacement.

After the trawling is finished, the cable is drawn up. It is important that this operation be performed regularly and without stoppage. That is why everything is arranged for detaching the apparatus from the cable in an instant. As an extreme precaution, care will be taken to keep the boat immovable and perpendicular over the cable, a thing that it is often difficult to do. It is unnecessary to say that sea fishing should be done in fine weather, but a slight surge does no damage, and I have even been surprised to see the apparatus descend and rise tightly closed, despite billows of a height of six feet.

At the moment of the immersion care must be taken to hold the apparatus by the bottom of the trawl in the first position (Fig. 5 *a*), for, without that, a little surface water might enter the trawl directly, before the latter tilted upward. So, too, on making its exit from the water, the apparatus may partially open for an instant if the precaution has not been taken to raise the linen at the posterior edge of the long frames (Figs. 4 and 5), so as to secure a rapid flow of the water imprisoned between this fabric and that of the shutter. That is why the fabric of the large frames is raised at one extremity by wooden wedges (Fig. 4, *f*).

I would recommend those who may be tempted to construct tilting trawls larger than mine to find, not only by calculation, but by direct experiment, what weight is necessary to keep the line from departing from the vertical by more than 15°, while the boat is running at half a knot. Under such conditions, a fine gauge allows the water to pass best, and the cosine of this angle is so small that it gives no appreciable error as to the measurement of the depth of the apparatus.

Moreover, there is nothing easier than to measure the angle, for a steel cable sufficiently weighted remains sensibly vertical when the boat is moving very slowly.

But those who have experience in fishing with steel cables will agree with me that such source of errors is very insignificant.—*Hermann Fol, in La Nature.*

COLORADO—A GEOLOGIST'S NOTES BY THE WAY.

To the Kansas City Academy of Science.

I submit a few notes on Colorado. Each visit impresses me more and more. Colorado is the Switzerland of America. But as the geologist is supposed to "run everything into the ground," I must curb my imagination and come down to earth. The eastern two-fifths of the State is a rolling plain, sometimes apparently level, and almost destitute of any vegetation except buffalo grass, which seldom exceeds three inches in height, broom or bitter sage brush, *Yucca mexicana* or "Mexican soapweed," and an occasional cactus of diminutive size. It is not generally known, but it is nevertheless a fact, that there is a ridge or divide that nearly parallels the Rocky mountains and is east of it from 60 to 80 miles. The Arkansas and Platte as well as the Republican rivers cut through this ridge. It is from 200 to 600 feet higher than the trough or sinus between it and the mountains. For instance, the highest land at Cedar Point—there are no cedars or other trees there—has an elevation of about 5,800 feet, while Denver, 76 miles west—and much nearer the mountains—has an elevation of only 5,170 feet. And again, Pueblo has about the same elevation as Denver, being a little less, but the mesa or table land that surrounds it has an elevation of about 5,600 feet, while Canon City, nestled at the foot of the mountains, 42 miles further west, has an elevation of only 5,280, one mile. I have never seen eastern Colorado when it was green. It springtime it is yellow, in autumn chocolate, and in winter brown. Most of the western country, where there are no evergreens, is much like eastern Colorado in the tints and hues of its landscapes.

From Canon City westward the grade is abrupt. Fremont's Peak, which overlooks the town, and is about five miles distant, has an elevation of nearly twice that of the town, or about 10,300 feet. Several peaks in the neighborhood are higher. Westward from Canon City, the railroad enters the canon of the Arkansas River, at about one mile and a half from town.

About five miles above town, the walls of the canon draw in till they are less than one hundred feet apart. They rise almost vertically 1,200 to 1,500 feet and then slope back abruptly to a height of about 4,000 feet above the railroad track. Around the base of the mountains, about on the dividing line between the coal measures and the Azoic rocks, is a limestone formation which stands or lies with its lines of deposition running at every angle between a vertical and a horizontal. I have observed this for a distance of 200 miles from Trinidad to the Platte River. At Canon City the convicts in the State penitentiary manufacture a fine lime from it. The "cap rock" of all the coal I have ever observed in Colorado, whether east or west of the mountains, is a soft, yellow, porous sandstone. Around Canon City, where this rock is not eroded, it is about 250 feet thick. At Trinidad it is not so well developed, yet it is present. At and around Como, in South Park, about 100 miles northwest of Canon City, and on the other side of a high range of mountains, the sandstone "cap rock" is from 50 to 100 feet thick.

The point in the canon, five miles from Canon City, described above, is called the Royal Gorge. For several miles, at least thirty, the Arkansas River passes through a canon with granite, quartzite, syenite or trachyte walls rising from 400 to 4,000 feet above the water. The first widening is called Pleasant Valley Park. The walls draw together again and then widen and resolve themselves into mountain slopes where they bound the beautiful North Park, along the east side of which flows the Arkansas River. This park is about fifty miles long and from five to twenty miles wide. At the lower east end lies the beautiful thrifty town of Salida, at an elevation of about 7,500 feet.

At the upper end of the park, at an elevation of about 9,300 feet, lies the mining town of Leadville, principally in California Gulch, a tributary of the Arkansas while a little above the center of the park, and in the only pine grove in it, is the town of Buena Vista, at an elevation of 8,000 feet. Inside of fifteen miles from this place are three mountains, Princeton, Harvard, and Yale, all of which are higher than Pike's Peak. It is not generally known, but there are more than thirty mountains in Colorado any one of which is higher than Pike's Peak. Buena Vista is one of the most beautiful little towns I ever saw in my life, but I must not digress.

Near Leadville, I was in sight of the source of the Arkansas River. Here it is a little trout brook. As I looked at its pure water and snowy surroundings, I could not help contrasting the scenery with that at the mouth of the river, where I spent six weeks, twenty-six

years ago, fighting, mostly mosquitoes, for my beloved country. I shed more blood on a flotilla near the mouth of the Arkansas river than if I had lost a limb. Yet the government has never, never offered me a pension!

From Buena Vista, I took the Gunnison branch of the Denver and South Park Railroad on the evening of the 20th of October and went to the mining camp of St. Elmo. Here I put in four days at altitudes varying from 10,000 to 13,000 feet above sea level. I examined several mining properties here. Had to take bromide of potassium to act as an arterial sedative to prevent hemorrhage of the nose and to quiet my nerves so I could sleep. From here I returned to Kansas City via Denver. From North Park and Buena Vista my route was through the Kenosha Hills and down the Platte canon.

I made some important observations on glacial drift, which I will proceed to give. For several months I have been interested in glacial phenomena in New Mexico. Perhaps it would be more exact to say interested in post-glacial drift, for the phenomena are certainly to be attributed to the post-glacial. Along the east side of the Rio Grande in New Mexico this drift is abundant. I observed it at a point on the Sante Fe Railroad about thirty miles south of San Marcial. Immense deposits are to be seen along the western boundary of the desert known as the Journado del Muerto (journey of death). At the time of my visit to that region last summer, I reached the conclusion that the immense deposits of breccia to be seen there are the accumulations around an extinct sea, *i. e.*, the gravel that indicated the beach line around such a sea. This breccia is composed of beautiful water-worn gravel of almost every color and a paste or matrix of alkali or alkaline earths and sand. This alkaline matrix in some instances is volcanic lime, and in others it is potassium salts. Near the old abandoned fort, McRea, there are thousands of acres of this formation that show croppings from twenty to one hundred feet in thickness. The pebbles and gravel in the formation are sometimes common brown or yellow chert, at others white or clouded quartz, topaz, agate, chalcedony, and occasionally an obsidian.

The extinct sea theory did not satisfy my reason, but I mentally accepted it as the best explanation I could give to myself at that time. My last two visits to Colorado have afforded the means of reaching a very different conclusion. All the breccia, gravel, pebbles or pronounced drift that are so abundant in the parks or wide valleys, on the mesas, deserts, and mountain sides in the Rocky mountain region, are undoubtedly of glacial or post-glacial origin. The ridge or divide mentioned above, the one in eastern Colorado, is composed largely of drift materials. Here it occasionally takes the form of a breccia, but more often it consists of deposits of sand and gravel thrown loosely together. There are three ways in accounting for this ridge.

1. It is a ridge whose bed rock was too hard to yield to the erosive influences of the ante-glacial waters that poured down the eastern slope of the Rocky mountains, and thus remained in the waters as a bar.

2. It is a terminal moraine or a series of terminals.

3. It is a lateral moraine.

If the first proposition is correct, the drift was deposited over the hard rock bar which already marked an elevation on the topography of the plains. These deposits would then only exaggerate the elevation. But I have failed so far to discover any hard bed rock. On the 9th instant, I noticed where a tributary of the Republican river crosses this ridge that the drift material is exposed to the river's bed. I conclude, therefore, that the first proposition is untenable or from data so hastily gathered is not satisfactorily established.

The second proposition, a series of terminal moraines, seems, likewise, unsatisfactory. It is improbable that a number of glaciers would have deposited such masses of material on so nearly the same line. This could not have happened unless the first clause of the first proposition is correct, that an ante-glacial ridge existed at the time of deposition. The facts adduced in discussing the first proposition seem to indicate the contrary.

The third proposition seems tenable. This is strengthened by the government reports, which set forth the fact that the glacial drift and the glaciers themselves moved through Colorado in a southeasterly direction along the eastern slopes of the mountains. It is several years since I read these reports, but this is my memory of them. I may be treating a subject that has been exhaustively discussed in some of these same reports, but so long as I am not aware of anything of the kind, I will proceed, not without realizing, however, that the ignorant frequently venture where the wise would desist. It seems probable to my mind that a large glacier paralleled the eastern base of the mountains. Near Denver it was moving in a southerly direction. This ridge is composed of the materials deposited along its eastern slope. As this glacier moved south, it gradually melted and became reduced in size.

This last assumption accounts for the fact that the sinus or trough is so much narrower between Pueblo and Canon City than it is east of Denver, *i. e.*, further north.

At the one place it is seventy-six miles from ridge to trough, at the other, the farther south, it is forty-two miles between ridge and trough. Just south of the Arkansas river at Pueblo the mountains swoop around, trend in an easterly direction. As this glacier moved south across the river it came in contact with the mountains and was probably about melted and otherwise annihilated by the time it reached Trinidad and the eastern arm of the Raton mountains. It is possible that the overflow of it passed through Cimarron Pass further to the southeast and found vent on the plains of the Pecos in eastern New Mexico. To sum up, then, the drift of Colorado is probably true glacial, while the drift of New Mexico is post-glacial, overflow from the glaciers farther north. The drift I observed, the breccia, in New Mexico, including that on the Journado del Muerto (Hoor-nah-do del Moo-ar-to) is overflow that came down the Rio Grande from the west slope of the Sangre de Christo and Raton mountains.

The Journado del Muerto lies between the Rio Grande on the west and the Pecos on the east. It reaches from near San Marcial (Mar-she-al) on the north, to Rincon on the south. It is about ninety by seventy miles in extent. It lies from 5,000 to 6,000 feet above sea level.

About all the drift on the plains above described in eastern Colorado lies at about the same level. The highest drift I observed was between Buena Vista and Leadville near the north end of North Park. Here it has an elevation of about 8,500 feet. The drift is very abundant in all of the parks or high valleys of Colorado. It is scarce along the gulches and canons, in fact, generally absent. I remarked this in Platte canon.

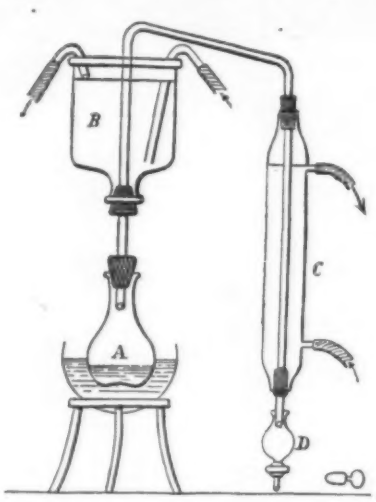
The reason for this is that the gulches and canons afforded such contracted outlets for the waters during the glacial and post-glacial epochs that all drift materials were brought in direct contact with the rushing waters, and the currents being so swift, they were carried to the plains and mesas below. This fact accounts for the absence of drift materials for so many miles along the upper North and South Platte rivers and its abundance along these streams after they leave the mountains. At no part of their upper course are they above the elevation at which I observed the drift in North and South parks and elsewhere in wide valleys. Notwithstanding drift is so abundant in the two parks drained by the Arkansas river, referred to in the first of these notes, there is none along the forty miles of the river where it passes through the Grand Canon. Yet it is very abundant below the canon, near Canon City, as stated above.—*Edwin Walters, K. C. Scientist.*

A QUANTITATIVE REACTION FOR LIGNIN.

R. BENEDIKT and M. BAMBERGER.

THE authors describe a number of experiments by which they have determined the methyl numbers of several kinds of wood, the experiments being a continuation of those on the ethereal oils (*Chem. Zeit.* 18, 873 and 1087; this *Journal*, 1890, 735 and 925) and resins (*Monatsch.* 11, 84; this *Journal*, 1890, 659).

Forty grammes of the wood shavings dried at 100° were put into the flask, A, together with 500° cc. of hydriodic acid of specific gravity 1·7 and containing 8



per cent. acetic anhydride. Heat was applied and the distillation of the methyl iodide produced was regulated by adjusting the temperature of the water in B. The distillate which collected in D proved to be nearly pure methyl iodide; it amounted to 4 grms., *i. e.*, 10 per cent. of the weight of the dry wood, but this does not represent the whole of the methyl iodide produced, as the apparatus remained full of vapor and part was no doubt lost. In the methoxyl determination (this *Journal*, 1889, 735) the methyl number obtained was 26·2, corresponding to 24·8 per cent. of methyl iodide.

Pure cellulose yielded no methyl iodide when boiled with hydriodic acid. On the other hand various woods which were boiled with water, dried, and then extracted for days, first with alcohol and then with ether, were found to give the same methyl number as the same woods when not so treated. From these results it is concluded that *lignin* is the constituent of the wood to which the methyl number is to be ascribed.

Assuming the correctness of Schulze's determination of the percentage of lignin in oak, namely 54·1 (*Chem. Centr.* 1857, 321), the authors are able to calculate from the methyl number of the same wood, namely, 28·6, that lignin should have the methyl number 52·9, and from this they also calculate the percentage of lignin in various woods:

	Methyl Number.	Percentage Lignin.	
		Benedikt and Bamberger.	Schulze.
Walnut shell	37·4	70·0	65·9
Holm oak	28·6	54·1	54·1
Alder	28·9	54·6	52·0
White beech	26·4	49·9	51·6
Acacia	24·2	45·9	47·0
Pine	21·3	40·3	42·0

The paper concludes with a table showing the methyl numbers obtained with a number of different woods and other substances. The woods examined gave methyl numbers varying from 20 to 31. The older wood near the center of the stem is shown to contain more lignin than the later rings, and the wood of a branch is richer in lignin than that of the stem. A comparison of the results obtained from lignite, peat and coal shows that the first has a methyl number corresponding with the woods, namely, 24·4, while that given by peat is 3·7, coal, on the other hand, yielding no methyl iodide when boiled with hydriodic acid.—*Jour. Soc. Chem. Industry.*

OZONE—ITS COMMERCIAL PRODUCTION AND APPLICATION.

By ERNST FAHRIG, T.E.

OXYGEN, besides being the most widely distributed element in nature, occupies a unique position among gases, in that it also exists in an allotropic form, possessing properties peculiar to itself, which strongly distinguish it from the parent body. In a manner which our knowledge of molecular physics is not yet sufficiently advanced wholly to indicate or explain, the oxygen can become subject to great internal tension, so that it undergoes a condensation to two-thirds of its normal bulk, and from a substance usually inert and stable is transformed into a powerful gas—a strong and energetic oxidant—which readily yields up a portion of its substance to assume again, without loss of volume, the condition of ordinary oxygen. This, as we shall presently show, is a property which would make this remarkable modification of the fire-sustaining element of enormous value in the arts and manufactures, were it possible to produce it upon a commercial scale.

To so produce it has been a problem of the age. Since its *first real* discovery in 1845, by Schonbein, of Basle, who gave it the name of ozone, several illustrious scientists, foreseeing the uses to which it can be put, have devoted much time and thought and experiment to the search for methods by which it might be prepared, outside of the laborious, expensive, and limited processes of the laboratory. With this view Schrotter, Bertholet, Frauenhofer, Siemens, Babo, Bunsen, and others all experimented with the gas, and set their giant intellects to the endeavor to discover means by which it could be commercially prepared and utilized. But they achieved little or nothing of success.

In fact, failure is the only epithet that can be inscribed over the records of their efforts in this direction.

Researches of inestimable value from a purely scientific point of view they carried through with all the enthusiasm and loving devotion of their natures. But they have done little to attract the attention or satisfy the requirements of the world of commerce. And commerce, that grasping entity from which even science cannot shake herself loose, still affects to treat this important discovery with disdain. Though now 45 years of age, it is still, in her way of thinking, in the embryo state, and while it so remains she refuses it the slightest assistance or notice.

Thus stands the matter at the present time, but we confidently hope that it will now be reversed, and this remarkable and useful agent advanced to its proper place in the scale of commercial utility. At our works we have met with the most gratifying results, quite justifying our claim that the labor of years has at last been crowned with complete success.

It may be asked why it has been possible for us to succeed where the great men named above have failed. In answer, we should submit, in all humility, that they each and all followed too closely in the footsteps of their predecessor, the pioneer, Schonbein. Moreover, the enormous advance of late years in electrical and dynamical science has brought more powerful forces and agencies to our aid. And we have been able to devote more time and patience to the problem than the other investigators had at their command. Fired many years ago by Professor Bunsen's saying that "If ozone could be produced on anything like a commercial scale, hundreds of uses could be found for it," we have thought and thought, and worked and worked, until it would have been strange indeed if our persistency had suffered defeat.

Let us then now review a few of the processes by which ozone has been prepared, and observe why these have no commercial value. First, there is the time-honored process of passing moist air over amorphous phosphorus. The *rationale* of this operation is somewhat obscure, but it is self-evident that it is not one that can be adapted to working on a large scale, and besides the ozone produced is of very indifferent quality and very impure. Secondly, oxygen is given off in the form of ozone when peroxide of hydrogen and potassic permanganate is acted upon by strong sulphuric acid. But this method is too expensive for commercial purposes, and in other respects is not satisfactory. Thirdly, when water is decomposed by an electric current, oxygen is separated partly in the form of ozone. Here there is only a partial formation in indefinite quantities, which uncertainty is quite sufficient to deter practical men from adapting such means.

Again there is a partial conversion of oxygen into ozone when it passes between terminals across which is projected, by means of a Rhumkorff coil, the brush of a powerful electrical discharge. But the same objections apply to this method as to the one immediately preceding; though we may say that it is the most promising of the whole, the one most susceptible of improvement, and to a certain extent it is the principle upon which we have worked and succeeded.

Of our own process we cannot in justice to ourselves give full details here; in fact, it would be quite premature to do so at the present time, but we have not the least doubt that it practically solves the problem, and opens out a grand field of enterprise for the use of this remarkable and potent gas. We produce the ozone directly from atmospheric air, a raw material that is absolutely free and costless, and make use of no expensive and difficult chemical manipulations. Our process is essentially a mechanical one, depending upon none of the tedious niceties of chemical science, but only proceeding in the bold, plainly defined way of the electrical engineer. It is by no means necessary that ozone should be already existent in the air used, for our process is a *creation* of ozone, not a mere separation of it from a medium in which it is already formed by the hand of nature. It is true that our apparatus exhibits a better result when sea air is used. But this is only natural, seeing exhaustive tests prove beyond question that an appreciable amount of ozone exists in the atmosphere contiguous to the sea, while on the other hand it is almost entirely absent in that over the land. Without doubt, the ozone thus present

plays an important and active part in the hidden processes of nature, for it is perfectly certain that so energetic an agency could not long remain a merely idle quantity. Indeed, it is possible that it may be a most important factor in the operations of organic chemistry.

Now to proceed to the artificial and commercial applications of the gas. These are manifold: Bunsen, indeed, did not exaggerate when he affirmed that hundreds of uses could be found for it. How numerous they are may best be estimated by summing up the large number of industries that are dependent upon the oxidation or chemical change of one or other of the constituents or materials employed in the manufactures.

To give them all would be to summarize the arts, which we cannot be expected to do within the compass of a short article. Suffice it to say, there are numerous operations in our great textile manufactures where oxidants have to be employed. The process of bleaching is an oxidizing of the crude coloring matter, and it is of the utmost importance that this shall be done thoroughly and without injury to the fibers of the fabric. The drying of oils, paints, and varnishes and the rapid finishing of certain manufactures, which now take weeks, require the use of oxidants, and these must be so selected that they introduce no extraneous or injurious substances. They have also sanitary and disinfecting applications, their active principle being to oxidize or literally burn up the offensive and infectious germs. Many more cases there are where different species of oxidants are in present and extensive use, but we cannot enumerate them now, and a little reflection will enable the interested reader to collect them for himself.

Now ozone can do all and more than can be done by the many and various oxidizing agents, which by long and painful experience have been selected, and hitherto found to be the most applicable to the various purposes required.

It is more rapid and energetic in its action, consists of nothing else but oxygen, and therefore cannot injure or adulterate, and it is capable of being presented and utilized in a host of different manners. In fact, from every point of view it is the very prince of oxidants. The reason why is not far to seek: it is its own solvent or menstruum. No ulterior medium is required to carry and present the necessary amount of free oxygen in a suitable degree of latency, nor does this obliging agent demand the substitution in itself of some other matter in exchange for that portion of its own substance of which it is despoiled. Instead, the transformed and overladen molecule of the operating gas lightly holds its additional atom, ready to yield it up to the absorbent body, at the slightest provocation or inducement. And thus both the medium and the active principle of the agent are oxygen, and purely oxygen. Nothing more need be introduced. Here there is no compulsory adulteration with other constituents, which in so many cases we are obliged to tolerate, even when they harm and deteriorate the material to which the oxidizing principle has to be applied. Here it is possible to proceed in the full assurance that the object is being attained in the simplest and most reliable of methods, nor is there cause for the least apprehension that the result may prove otherwise than is wished. And here is something of truly immense concern in such manufacturing operations as the bleaching of sugar, of pulp, and of some textile fabric where it is absolutely necessary that the original purity of the material treated must be preserved and jealously guarded from the intrusion of anything alien or destructive to its nature.

These important facts constitute the immense superiority of a process of ozone oxidizing over any of the methods now in vogue. Nothing foreign is added, so that nothing extra of that nature has to be neutralized or removed. What a momentous question it is to our manufacturing industries, how greatly it affects the commercial interests and enterprise of the country, will easily be seen on due inquiry into the subject. For the whole history of some of the arts is that of one long struggle against troubles and difficulties introduced by the necessary operations of bleaching, oxidizing, and like requirements of technical science.

Need we say more to emphasize the enormous practical utility that ozone must ultimately attain to, when it is definitely shown and acknowledged that it can be produced on a commercial scale and commercially applied. Its coming into use for industrial purposes would at one grand stroke sweep away mountains of obstacles from the path of progress, and deliver us from a small occupying army of useful but dangerous chemical agents, whose terrible side play of adulteration and destruction militates so seriously against their value in the work for which we require them; and which all the arduous labor of a long range of years has only been able partially to meet and overcome. Further, it will open out a field of labor pregnant with new possibilities, which our great army of alert and intelligent factors will not fail to cultivate and adapt to the uses of mankind. One especially of these new uses we ought not to pass over without mention. It is the deodorizing and precipitation of sewage. Our experiments in this direction show that ozone can be most successfully applied for this purpose; indeed, we fancy that this great problem must be eventually solved by its aid.

Here then is a truly gigantic question, one of the highest possible importance to our country and times, inviting and awaiting a trial of perhaps the most powerful, and certainly the most convenient, oxidant available in nature. Whether ozone is to be thus tried is of course a question for the powers that be; who it is to be hoped will not, in the folly of their wisdom, long refuse to give it the notice it deserves.

It is now our hope and pride that, through our humble though earnest endeavors, ozone is at length to be started upon a long life of great and evergrowing usefulness; and in seeing it thus assume its ordained functions we shall have our reward. We doubt not that it will prove fully capable of all the applications we have assigned to it; and of many more which the progress of time, of science, and of commerce is sure to discover. Neither do we doubt our own success, or our ability to prove it to the most exacting critics, to whom, if they wish it in a serious scientific and unprejudiced spirit, our experimental works and plant are always open to inspection. And we have achieved this, not on the small and misleading scale of the laboratory, but with plant and appliances especially designed and built for the purpose of preparing and utilizing the gas under actual commercial conditions. Having done this, we can justly claim that we have taken every means to arrive at true and accurate results; and that our apparatus has come satisfactorily through the severest possible tests. Thus we think we have effectually solved the problem we set ourselves, which was to produce ozone on a commercial scale and at a commercial price which will enable it to be used with profit and to good purpose in many of our most important industries. Of course much remains still to be done; there is its actual introduction to the world of commerce; an often long, arduous, and we might almost say thankless process. It means a teaching of a new trade to artisans who too often are so wise and obstinate in their experience as to refuse to learn even where it is quite essential that they shall submit to be taught. Then there is the fearful aspect of pounds, shillings, and pence forever staring one in the face, and deadening and stifling one's vital enthusiasm. It is this that has too often deterred eminent men from taking the reward that seemed within their grasp. They saw from afar off the pains and penalties of anxious, sordid care that awaited any attempt to bring their discoveries into practical use for the benefit of the general public, and they shrank from them in distaste fear, and left the development of their work in less capable hands.—*Chem. Tr. Journal.*

ROLLING CURVES.

IN Fig. 1 we have taken two circles, one twice as large as the other, and arranged matters for rolling them together back and forth upon the same straight line as though they were two hoops made to run side by side along the same path. It is evident that if a point in the circumference of the inner circle be taken, as at B, for instance, it must move along the cycloid from A to C, while the circle makes one revolution, and at the same time make one sweep across the larger circle through the center on the line, *a*, *b*, bringing this line upon the end at both E and F, as shown by the dotted position, the larger circle making one-half of a turn while the inner circle is turning around once. Here we have a case where both lines are being drawn at the same time by a single tracing point, showing plainly that the two must have been in contact from one end of the cycloid to the other. In other words, the line, *a*, *b*, must have slid over the curve, A, B, C, endways on the tracing point, B, keeping outside the curve continually. This being the case, we can leave out the circles and take a line of the length, *a*, *b*, and oblige each extremity to follow in the path of a cycloid generated by the large circle, and it will always keep tangent to another generated by the small circle. Every diameter of a wheel while rolling along is playing leap frog over a series of cycloids generated by a wheel of one-half the size. When it comes over to stand upright, as at *a*, A, in Fig. 2, it turns on the point of contact for an instant, one extremity following along the curve, *a*, B, the other keeping on a similar curve, from A to D, the line itself keeping clear of the space, A, E, B, corresponding to the cycloid of one-half the length of space the lines are following.

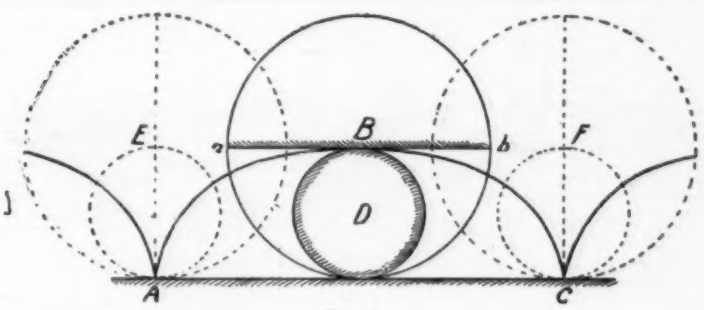


FIG. 1.

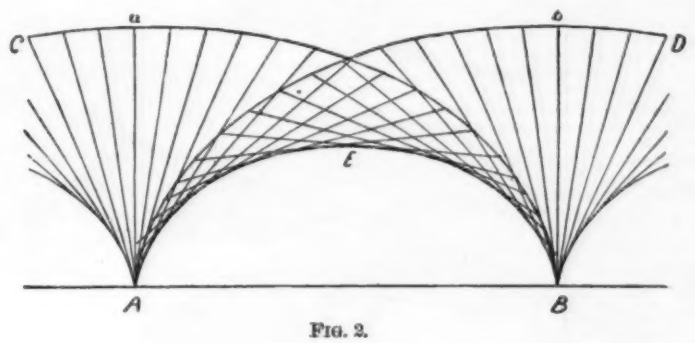


FIG. 2.

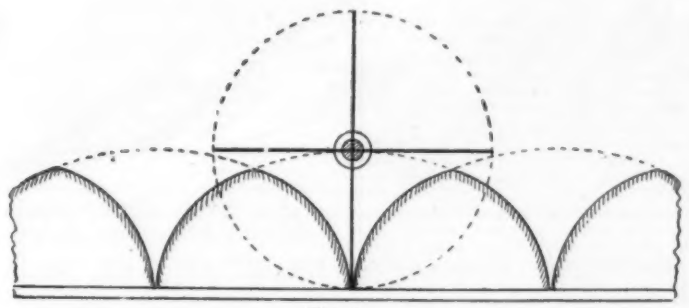


FIG. 3.

In Fig. 3 may be seen how much space is required for two diameters of a rolling circle to operate in when operation. The amount of gelatine on the plates is rarely of the first importance in most photographic experiments, consequently its determination would serve no practical purpose.

We are left then with the task of arriving at the quantity of silver bromide either alone or in the presence of iodide contained in the films. Chloride is never present in negative emulsions.

Now, everybody knows that the presence of silver iodide in a film can at once be detected by the yellow tint which the plates present when viewed in daylight. If plates of different brands and of various rapidities are compared in this manner, we can mark the distinction between the films of pure bromide and those containing iodide. We shall also notice that some of the iodide plates contain considerably more of that haloid of silver than others, and that the preponderance is not always on the side of the slow plate. It is not often that photographic experimenters want to know how much silver bromide a commercial film contains, so that on the present occasion we will confine ourselves to a consideration of the method suggested for ascertaining the proportion of iodide to bromide present in a given batch of emulsion.

The first thing to do will be to get a quantity of the batch tested in a liquid state, and in order to secure it, it will of course be necessary to strip a few films, since we cannot expect the plate makers "to oblige" in the matter.

The stripping can be done by soaking the plates in water for an hour and lifting the edges of the films, when they will "peel" from the supports. I believe

ANALYSIS OF COMMERCIAL GELATINE PLATES.

COMMERCIAL gelatine plates have been brought to so high a degree of excellence that not only is there no inducement for an ordinary amateur to prepare his own emulsion, but even scientific men, some of whose names are not quite unrelated to the practical advancement of gelatine emulsion in its earlier days, invariably prefer, when they have important photographic investigations or experiments on hand, to purchase their plates of some reputable maker. It would have been thought that the safer course for a scrupulous student to take would be to make his own emulsion, so that he could know just exactly of what his sensitized films consisted, and could add to the statistics of his results accordingly, but we never find this done. The fact of it is that plate making, before a constancy of success is obtained, requires an intolerable deal of what Cicero told an interlocutor gave him his powers of oratory, and modern men of science have something else to do besides practicing emulsion making.

The gelatine plates nowadays made for exposure in the camera presumably do not contain silver nitrate in excess, while we can further be confident that the alkaline nitrates formed by double decomposition have also been absolutely removed; therefore, we may consider testing for the presence of those salts a superfluous

that the average quantity of gelatine emulsion required for coating a whole plate is a fluid drachm, so that if four whole plates or their equivalent are stripped, we shall get about half an ounce of emulsion, which will be plenty for our purpose.

When the films have been collected, they should be placed in a bottle and dissolved in a small quantity of water by the aid of heat, a couple of ounces of strong nitric acid added, and the mixture allowed to digest over heat for a few hours. At the end of that time the haloids will be precipitated at the bottom of the vessel.

Alcohol in an emulsion can be detected by treating a small quantity of it with sulphuric acid, when the characteristic odor of ether will be given off. The amount present is never large, so that distillation in order to get at the precise quantity is really unnecessary. It is improbable that antiseptics are added to modern emulsions, hence it is needless to test for them. The slight excess of soluble bromide present is of no importance in any treatment which the unexposed films may receive.—*Thomas Bedding, in Br. Jour. of Photo.*

PHILADELPHIA A PORT OF ENTRY.

WE give from *The Manufacturer* an engraving of a plan proposed by Mr. F. A. Mahan, for the conversion of Philadelphia into a port of entry. This is to be accomplished by a purchase of the private property along the Delaware river front, so as to make a broad and noble avenue, 375 feet in width, on which the largest steamers afloat may find ample and convenient discharge. The enterprise proposed is a grand one, and if carried out on the scale proposed, would have the effect to increase the commercial prosperity of the city of Brotherly Love in a very marked degree. Philadelphia is already the greatest manufacturing center in this country, and almost stands first in wealth and population. All she needs in order to eclipse the other larger cities is the addition of new and superior marine facilities. Were Philadelphia in possession of the splendid bays and harbors which New York enjoys, or free water communication with the great lakes such as Chicago commands, it is probable that Philadelphia would be the equal of London, both in population and financial power.

Mr. Mahan says: "Of the five essential features of a great port, Philadelphia possesses none. Access to the sea is impossible at all times for vessels of the largest size. There are neither the wharves nor the wharf equipment for loading and unloading a large vessel quickly. The means of access to and departure from the wharves are inconvenient to the last degree on the city side. Access to the interior of the country is only to be had by rail. Conveniences for repairs are not up to the standard of a large commerce, and prices are such that a foreign ship will wait, if possible, to have her overhauling done at the home port.

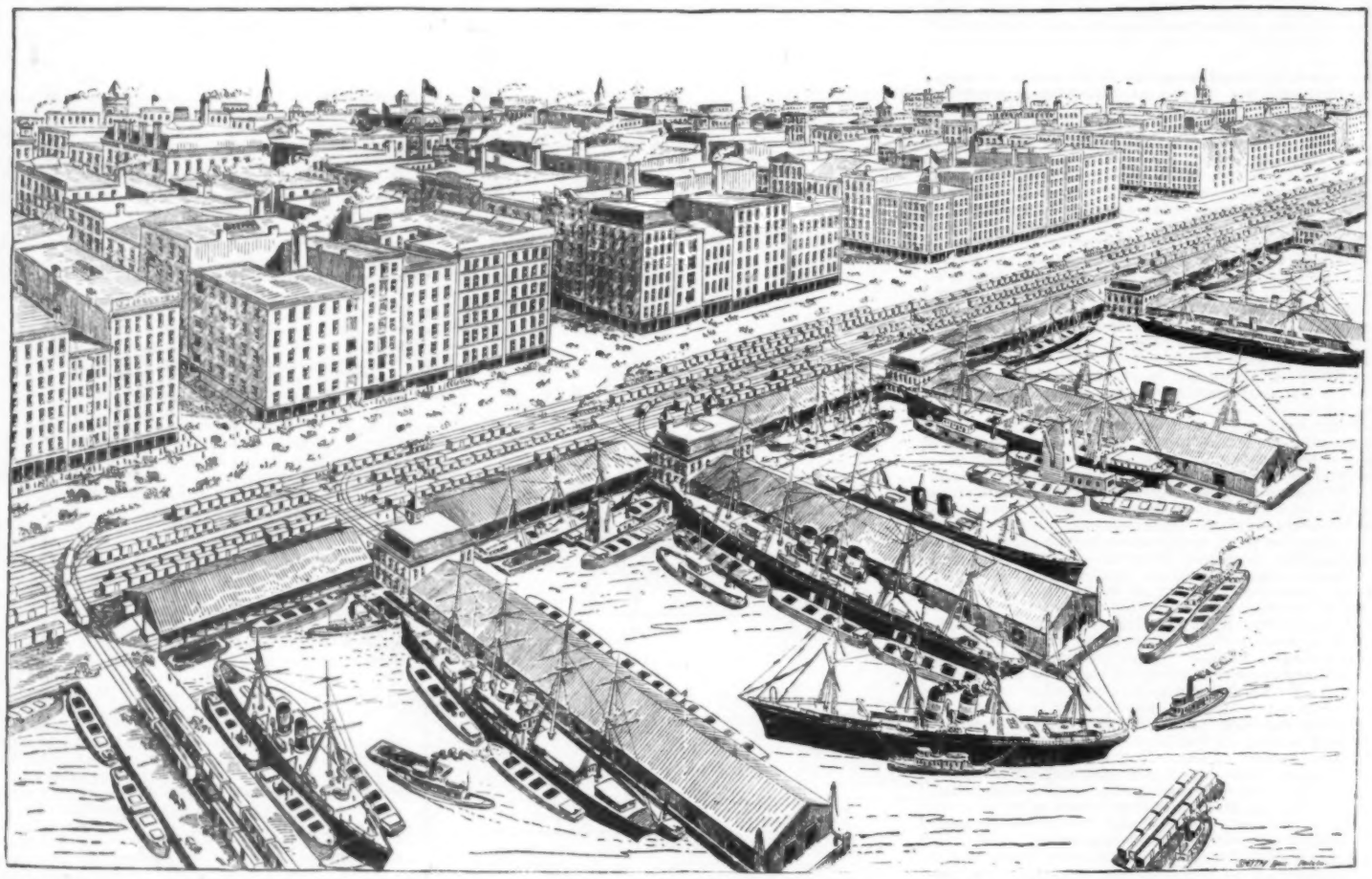
"The most important part of the great undertaking of making Philadelphia a seaport of the first order is a broad street for traffic. A width of less than 125 yards from the bulkhead line to the building line should not be considered. The ships of the future will probably be larger than those of the present, as those of the present are larger than those of the past. The reason is plain. The larger the ship, the less expensive proportionately are the running expenses. A ship of 7,000 tons needs no more officers than does one of 3,500. The cost of propelling a large ship is not double the cost of one of half the capacity at the same speed.

"These large vessels demand room in which to turn and maneuver. The width of the stream must not be reduced. As the street must be widened, let this take place toward the city. Go back to Front street, go back to Second street, if necessary, and clear the entire ground. Make the new street what it should be; suitable for the business of this city a hundred years hence. The city will lose nothing in the present by taking such a course.

"A street having the width mentioned would give room for light tracks for railways, a double track street car line and a broad roadway for teams. There would also be room along the bulkhead for sheds, through which the commerce of small craft would be carried on."

IRON-ALUMINUM ALLOY.

A PROCESS for adding a slight percentage of aluminum to iron, thereby increasing its strength, has been experimented upon for some time in Germany. Most of the processes thus far tried have been quite expensive, but the one referred to aims to reduce this expense to a very small figure. According to the *Railway Review*, a certain amount of emery and alum, generally in the form of a fine powder, is added to the pig in the cupola, or is put in the blast furnace, and it is claimed that under great heat the reaction of the alum on the emery produces vapors of metallic aluminum, which immediately forms with the iron an alloy which is not affected by the later action of the blast, all of the aluminum being found in the iron that leaves the furnace or cupola.



Total distance from building line on Delaware Avenue to end of piers, 850 feet. Width of sidewalk, 20 feet. Roadway, 70 feet. Steam railroad tracks, 80 feet. Bulkhead sheds, 80 feet. Length of piers, 600 feet.

SUGGESTIONS FOR IMPROVEMENT OF THE DELAWARE RIVER FRONT, PHILADELPHIA.

PRIZES AWARDED AND OFFERED AT THE ACADEMY OF SCIENCES, PARIS, ON DECEMBER 29, 1890.

THE following prizes were awarded to successful competitors in 1890:

Geometry.—Grand Prix des Sciences Mathematiques, M. Paul Painleve; honorable mention, M. Leon Autonne; Prix Bordin (not awarded); Prix Francœur, M. Maximilien Marie; Prix Poncelet, M. le General Ibanez.

Mechanics.—Extraordinary prize of 6,000 francs—this has been divided between M. Madamet, MM. Ledieu and Cadiat, and M. Louis Fave; Prix Montyon, M. le Colonel Locher; Prix Plumey, M. Jules-Ernest Boulogne.

Astronomy.—Prix Lalande, M. J. V. Schiaparelli; Prix Damoiseau (not awarded); Prix Valz, Prof. S. de Glasenapp; Prix Janssen, Prof. C. A. Young.

Statistics.—Prix Montyon, Dr. Paul Topinard; honorable mention, M. Dislere.

Chemistry.—Prix Jecker, divided between the late M. Isambert and M. Maurice Hauriot.

Geology.—Prix Vaillant, M. Marcel Bertrand; Prix Fontannes, M. Ch. Deperet.

Physical Geography.—Prix Gay, M. Franz Schrader.

Botany.—Prix Desmazieres, M. Maurice Gomont; Prix Montagne, divided between M. Paul Hariot and Dr. Albert Billet.

Anatomy and Zoology.—Prix Bordin (not awarded); Prix Savigny, divided between Dr. Jousseaume and M. R. P. Camboue; Prix Thore (not awarded); Prix Serres, M. Camille Dareste.

Medicine and Surgery.—Prix Montyon, divided between M. Felix Guyon, M. Auguste Ollivier and M. Paul Richer; mentions were accorded to M. Ch. Fiessinger, MM. J. Chauvel and H. Nimier, and M. Ch. Maurinc; Prix Breant, divided between M. G. Colin and M. A. Layet; Prix Godard, M. Samuel Pozzi; honorable mention, MM. Ch. Monod and O. Terrillon; Prix Barbier, M. Claude Martin; honorable mention, M. Gaston Lyon and M. B. Dupuy; Prix Lallemand, divided between Mme. Dejerine-Klumpke and M. G. Guinon; Prix Dusgate (not awarded); Prix Bellion (not awarded); Prix Mege, M. Nicaise.

Physiology.—Prix Montyon, divided equally between M. E. Gley and M. E. Wertheimer; honorable mention, M. E. A. Alix and MM. G. Arthaud and L. Butte; Prix Pourat (not awarded).

General Prizes.—Prix Montyon (Unhealthy Industries), M. Casimir Tollet; Prix Jerome Ponti, M. R. P. Colin; Prix Tremont, M. Beau de Rochas; Prix Gegner, M. Paul Serret; Prix Delalande-Guerineau, Dr. Verneau; Prix de la fondation Leconte, M. Prosper de Lafitte; Prix Laplace, M. Bailly.

The following prizes were proposed for the year 1891:

Prix Francœur: For discoveries or useful works tending to further the progress of pure and applied mathematics.

Prix Poncelet: For the author of any work tending most to further the progress of pure and applied mathematics.

Extraordinary Prize of 6,000 francs: Any improvements tending to increase the efficiency of the French naval forces.

Prix Montyon: Mechanics. Prix Plumey: Improvement of steam engines or any other invention contributing most to the progress of steam navigation. Prix Dalmont: For the engineer who shall present to the academy the best work on bridges or on highways. Prix Fourneyron: Improvements in the theory of steam engines which take most account of the changes of heat between the water and the cylinders and tubes.

Prix Lalande: Astronomy. Prix Damoiseau: Improvements of the lunar theory which consider inequalities of long period caused by planets. Prix Valz: Astronomy. Prix Janssen: Astronomical physics. Prix Montyon: Statistics.

Prix L. La Caze: The best work on physics, chemistry, and physiology.

Prix Jecker: Inorganic chemistry. Prix Delesse: The author of the best work on geological science, or, in default of such, mineralogical science. Prix Bordin: The study of the phenomena of the fecundation of Phanerogamic plants, with particular reference to the division and transport of the cellular nucleus; also the study of the connections which exist between these phenomena and those observed in the animal kingdom. Prix Bordin: Comparative study of the auditory nerves of warm-blooded Vertebrata; Mammiferæ and Birds. Prix Desmazieres: The best work on the whole or any part of Cryptogamic flora. Prix Montagne: The author of important works on the anatomy, physiology, development, or description of the lower Cryptogamic plants. Prix Thore: Works on the

cellular Cryptogams of Europe, and on the habits or anatomy of any species of European insect, alternately. Grand Prix des Sciences Physiques: On the organs of sense of Invertebrata, from an anatomical and physiological point of view. The prize may be awarded for a complete work on one of the organs of sense in a group of Invertebrata. Prix Savigny: For young zoological travelers. Prix da Gama Machado: On the colored parts of the tegumentary system of animals, or on the genital matter of living beings. Prix Montyon: Medicine and surgery. Prix Breant: The discovery of a cure for Asiatic cholera. Prix Godard: On the anatomy, physiology, and pathology of genito-urinary organs. Prix Chaussier: Important works in legal or practical medicine. Prix Barbier: The most important discovery in surgery, medicine, pharmacy, and botany, having reference to the healing art. Prix Lallemand: Researches on the nervous system in the widest sense of the term. Prix Bellion: Works or discoveries serviceable to the health or to the improvement of the human species. Prix Mege: The author of a continuation and completion of Dr. Mege's essay on the causes that have retarded or favored the advancement of medicine. Prix Montyon: Experimental physiology. Prix Pourat: Functions of thyroid bodies. Prix Martin-Damourette: Therapeutic physiology. Prix Gay: Newly formed lakes and how they become stocked. Prix Montyon: Unhealthy industries. Prix Cuvier: The most remarkable work on the animal creation, or on geology. Prix Tremont: For any naturalist, artist, or mechanic, needing help for carrying out any project useful and glorious for France. Prix Gegner: In aid of any man of science distinguished for his works toward the advancement of the positive sciences. Prix Jean Reynaud: For the most meritorious work produced in a period of five years. Prix Petit d'Ormoy: Pure and applied mathematics, or applied and natural science. Prix Laplace: For the best student leaving the Ecole Polytechnique.

[Continued from SUPPLEMENT, No. 789, page 12609.]

THE POWER OF WATER, OR HYDRAULICS SIMPLIFIED.

By G. D. HISCOX.

THE FLOW OF WATER THROUGH PIPES.

THE practical conditions of flow of water through long pipes depends upon head or height of source above point of discharge, length and diameter of pipe, and friction; the active power being gravity.

The laws in relation to the flow may be briefly summed up as follows:

1st. The loss in friction is proportional to the length of the pipe, with equal velocities.

2d. The friction increases nearly as the square of the velocity.

3d. The friction decreases with the increase of diameter of the pipe, for a given length.

4th. It increases with the roughness of the interior surface.

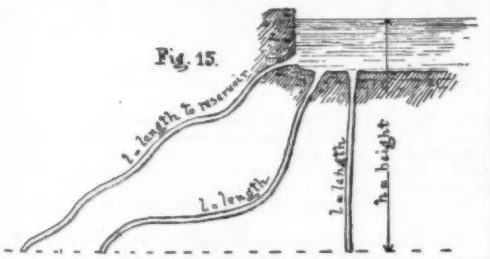
5th. It is independent of the pressure.

6th. In wooden pipes the friction is 1·75 greater than in metal pipes.

In order to utilize the full flow of water through pipes by gravity or pressure, the entering end should be bell-mouthed or curved out in a long cone, eight or ten times the diameter of the pipe in length, the end of the cone or bell being no larger than twice the area of the pipe.

In Fig. 15 are illustrated the conditions for the following formula and tables in which the height is the vertical elevation of the surface of the water in the reservoir or pond above the point of discharge, and the length of pipe along its line; not the horizontal distance.

Fig. 15.



The apparently simple formula for the flow of water through long pipes may be expressed thus:

$$\sqrt{\frac{d^5\,h}{\text{length}}} \times 4{\cdot}71 = \text{volume in cubic feet per minute;}$$

where d is the internal diameter of the pipe in inches, raised to its fifth power, or multiplied 4 times upon itself and its sums. Thus the fifth power of 2 is $2 \times 2 = 4 \times 2 = 8 \times 2 = 16 \times 2 = 32$. The fifth power of 3 multiplied in the same manner is 343. h is the head or height of water supply above the orifice; l is the total length of the pipe; and 4·71 is a coefficient applicable to the varying conditions of the square root of the other terms of the equation.

The square roots for all numbers up to 1,600, with a simple rule for any number higher, and for decimals, may be obtained from Haswell's or Nystrom's engineers' pocket books.

For example: What will be the flow from a 2 inch pipe 1,000 feet long, with a fall of 25 feet? The formula will then be:

$$\sqrt{\frac{2^5 \times 25}{1000}} \times 4{\cdot}71 = \text{volume in cubic feet per minute.}$$

The fifth power of 2 is $32 \times 25 = \frac{800}{1000} = 0{\cdot}8$ and square root of 0·8 is $0{\cdot}894 \times 4{\cdot}71 = 4{\cdot}21$ cubic feet per minute, and $4{\cdot}21 \times 7\frac{1}{2} = 31{\cdot}57$ gallons per minute.

For convenience we append a table containing the equivalent of the square root of the fifth power by inversion of the other terms for ordinary sizes of iron pipe from ½ inch to 48 inches in diameter.

This requires only the factors of head and length of pipe, with the tabular number for size, to complete the equation for a discharge of cubic feet per minute, for round tubes.

The quantities in the table, opposite the sizes of pipe, represent the square root of the fifth power of the diameter of the pipe in inches, multiplied by 4·71, from Eytelwein's formula.

Diam. inches.	Tabular No.	Diam. inches.	Tabular No.	Diam. inches.	Tabular No.
½	0·83	4½	194·84	20	8,440·0
¾	2·29	5	263·87	22	10,722·0
1	4·71	6	416·54	24	13,328·0
1¼	8·48	8	854·99	26	16,278·0
1½	13·02	10	1,493·5	28	19,592·0
2	26·69	12	2,356·0	30	23,292·0
2½	46·67	14	3,465·3	36	36,725·0
3	73·55	15	4,115·9	42	53,995·0
3½	108·14	16	4,936·9	48	75,292·0
4	151·02	18	6,493·1		

By the use of this table the more simple formula of

$$\frac{\text{Tabular number}}{\sqrt{\frac{\text{Length of pipe}}{\text{Head or height}}}} = \text{volume in cu. ft. per minute.}$$

Take the terms of the last example for a 2 inch pipe, the tabular number for a 2 inch pipe is 26·69. The equation then becomes $\frac{26{\cdot}69}{\sqrt{\frac{1000}{25}}}$, then $\frac{1000}{25} = 40$ and $\sqrt{40} = 6{\cdot}324$, and $\frac{26{\cdot}69}{6{\cdot}324} = 4{\cdot}22$ cubic feet per minute.

For the velocity of flow in pipes, where the area and quantity are both known, the simple equation is

$$\frac{\text{Volume in cubic feet}}{\text{Area in square feet}} \text{ or}$$

$$\frac{\text{Volume in cubic feet} \times 144 \text{ square inches per foot}}{\text{Area in square inches}} \text{ or}$$

$$\frac{V \times 144}{D^2 \times 0{\cdot}7854} = \text{velocity in feet per minute.}$$

When D is the diameter in inches and V is the volume in cubic feet per minute, or if in gallons, divide by 7·48 for cubic feet.

Again, taking the preceding example of a 2 inch pipe discharging 4·22 cubic feet per minute,

$$\frac{4{\cdot}22 \times 144}{3{\cdot}1416} = 193{\cdot}34 \text{ feet per minute velocity.}$$

If the diameter of the pipe is given in feet and decimals of a foot, the equation becomes simply

$$\frac{\text{Volume}}{D^2 \times 0{\cdot}7854} = \text{velocity in feet per minute.}$$

The loss of head due to curves, as when the pipe is bent to a radius of over 15 diameters, needs no consideration in ordinary practice, but for cast iron elbows as used with wrought iron pipe, the square of the velocity in feet per second × 0·139 for 45 deg. elbows, and 0·98 for right angle elbows; and product divided by twice gravity,

$$\frac{V^2 \times 0{\cdot}139}{64{\cdot}33} \text{ or}$$

$$\frac{V^2 \times 0{\cdot}98}{64{\cdot}33}$$

will be the loss of head in feet or decimals of a foot for each elbow respectively.

An example becomes for one right-angled elbow for velocity as per last example,

$$\frac{193{\cdot}34}{60 \text{ seconds}} = 3{\cdot}2 \text{ feet per second velocity.}$$

Then $\frac{3{\cdot}2^2 \times 0{\cdot}98}{64{\cdot}33} = 0{\cdot}156$ foot, loss of head for one elbow.

This amount is so small that it may be discarded for a half dozen elbows where the velocity is under 5 feet per second. Where pipes of moderate length and high velocities are to be used, and the highest efficiency required, elbows should be discarded and long radius bends used, as a single example with a velocity of 10 feet per second will show.

Then $\frac{10^2 \times 0{\cdot}98}{64{\cdot}33} = 1{\cdot}52$ feet loss of head for each short elbow of 90 deg.

Gate valves should be used wherever greatest efficiency of flow is required. The entrance heads of all pipes, especially where the largest efficiency is required, as for power purposes, should have a long bell mouth, and, if possible, with an increasing curve, for the purpose of avoiding the loss by the contracted vein at entrance head. This may be no longer than from 6 to 10 times the diameter of the pipe. For entrance heads at springs and reservoirs, the bell mouth may be made of galvanized sheet iron, and neatly inserted in the socket of the wrought iron pipe. For cast iron, they are made under the name of reducing pieces, with the small end to fit the socket end of the cast iron pipe.

The following table, showing the computed loss of head by friction in pipes from 1 to 14 inches in diameter, and for a length of 100 feet, will be found very convenient, the loss of head being proportionable for any multiple of 100 feet, friction being in proportion to the water surface of the pipe, also the discharge in cubic feet for different velocities, and the velocity of a given discharge for various size pipes from 1 inch to 14 inches in diameter:

LOSS OF HEAD BY FRICTION OF WATER IN PIPES. COMPUTED FOR PIPES ONE HUNDRED FEET LONG.

Velocity through Pipe in Feet per Second.	Inside Diameter of Pipe in Inches. 1		2		3		4		5		6		8		10		12		14	
	Discharge per Minute in Cubic Feet.	Loss of Head in Feet by Friction.	Discharge per Minute in Cubic Feet.	Loss of Head in Feet by Friction.	Discharge per Minute in Cubic Feet.	Loss of Head in Feet by Friction.	Discharge per Minute in Cubic Feet.	Loss of Head in Feet by Friction.	Discharge per Minute in Cubic Feet.	Loss of Head in Feet by Friction.	Discharge per Minute in Cubic Feet.	Loss of Head in Feet by Friction.	Discharge per Minute in Cubic Feet.	Loss of Head in Feet by Friction.	Discharge per Minute in Cubic Feet.	Loss of Head in Feet by Friction.	Discharge per Minute in Cubic Feet.	Loss of Head in Feet by Friction.	Discharge per Minute in Cubic Feet.	Loss of Head in Feet by Friction.
1	0·327	0·588	1·30	0·294	2·95	0·196	5·23	0·147	8·17	0·118	11·77	0·098	20·88	0·074	32·70	0·059	47·10	0·049	64·08	0·042
2	0·654	1·97	2·60	0·989	5·89	0·659	10·44	0·494	16·34	0·395	23·54	0·329	41·76	0·247	65·40	0·198	94·20	0·164	128·16	0·141
3	0·981	4·05	3·90	2·02	8·83	1·35	15·67	1·02	24·51	0·815	35·32	0·679	62·64	0·509	98·15	0·407	141·30	0·339	192·24	0·291
4	1·30	6·84	5·20	3·42	11·80	2·28	20·89	1·71	32·69	1·37	47·09	1·14	83·52	0·856	130·85	0·685	188·40	0·570	256·32	0·489
5	1·63	10·2	6·50	5·14	14·70	3·43	26·12	2·57	40·87	2·05	58·87	1·71	104·40	1·28	163·50	1·03	235·40	0·855	320·40	0·735
6	1·96	14·3	7·80	7·17	17·70	4·78	31·34	3·59	49·05	2·87	70·64	2·39	125·28	1·79	196·20	1·43	282·50	1·20	384·48	1·03
7	2·29	19·1	9·10	9·52	20·60	6·35	36·57	4·77	57·22	3·81	140·16	2·39	228·90	1·99	329·0	1·59	448·57	1·36		
8	2·61	24·4	10·40	12·2	23·56	8·14	41·79	6·11	65·40	4·89	94·19	4·07	167·04	3·06	261·60	2·45	376·70	2·04	512·68	1·75
9	2·94	30·3	11·70	15·2	26·51	10 12	47·02	7·59	73·57	6·07	105·97	5·06	187·92	3·79	294·29	3·03	423·80	2·53	576·75	2·17
10	3·27	37·0	13·0	18·5	29·45	12·32	52·24	9·24	81·75	7·39	117·74	6·16	208·80	4·62	327·00	3 70	470·90	3 02	640·84	2·64
11	3·59	44·1	14·3	22·0	32·40	14·71	57·47	11·03	89·92	8·82	129·52	7 36	229·68	5 52	359·70	4·41	518·00	3·68	704·93	3·15
12	3 92	51·9	15·6	26·0	35·34	17·31	62·70	12·98	98·10	10·38	141·30	8·67	250·56	6·49	392·39	5·19	565·10	4·32	769·02	3·71
13	4·25	60·0	16·9	30·0	38·33	20·10	67 92	15·08	106·27	12·06	153·07	10·05	271·44	7·54	425·00	6·03	612·20	5·03	833·10	4·30
14	4·58	69·0	18·2	34·0	41·23	23·12	73·15	17·34	114·45	13·87	164·85	11·56	292·32	8·67	457·79	6 93	659·30	5·78	897·18	4 95
15	4·90	79·0	19·5	39·0	44·20	26·32	78·38	19·74	122·62	15·79	176·63	13·16	313·20	9·87	490·49	7·90	706·35	6·38	961·27	5 64
16	5·23	88 0	20·8	44·0	47·12	29·72	83·60	22·29	130·80	17·83	188·40	14·86	334·08	11·15	523·18	8·92	753·45	7·43	1025·96	6·37
17	5·56	100·0	22·1	49·0	50·05	33 33	88·83	25 00	138·97	20·00	200·18	16·67	354·96	12·50	555·88	10·00	800·50	8·33	1089·45	7·15
18	5·89	111·0	23·4	55·0	53·0	37·14	94·05	27·86	147·15	22·29	211·96	18·57	375·84	13·93	588·58	11·14	847·60	9·29	1153·54	7 96
19	6 21	123·0	24 7	61·0	55·95	41·12	99·28	30·84	155·32	24·67	223 73	20·56	396·72	15·42	621·28	12·34	894·70	10·28	1217·63	8·81
20	6 54	136·0	26·0	68·0	58 89	45·32	104·50	33·99	163·50	27 19	235 51	22 66	417·60	17·00	653·98	13 60	941·75	11·35	1281·72	9 71

The above table will also be found convenient for engineers using pumping machinery, for ascertaining the work of the pump due to friction; thus, in pumping through 250 feet of 1 inch pipe at the rate of 3·27 cubic feet per minute, as per table, the velocity is found to be 10 feet per second, and the friction 37 feet for 100 feet of pipe; $37 \times 2\frac{1}{2}$ hundred feet equals $92\frac{1}{2}$ feet head, and $92\frac{1}{2} \times 0{\cdot}433 = 40$ lb. pressure per square inch, due to friction alone. Any quantity in discharge between the figures as given in the table will have equal proportions in each of the columns for velocity and friction.

(To be continued.)

[Continued from SUPPLEMENT, No. 790, page 12618.]

ELECTRIC MOTIVE POWER ON ELEVATED RAILWAYS.*

By WILLIAM NELSON SMITH.

GENERAL DESIGN OF AN ELECTRICAL SYSTEM FOR THE ELEVATED ROADS OF CHICAGO.

HAVING outlined the general method to be followed in designing the electrical equipment of an elevated road, we will now look more closely into the various details, as affected by the given conditions.

Chicago was selected as the scene of operations for several reasons. Three elevated systems are now projected or in process of construction in that city. As they will not be in operation for some time to come, there is perhaps a slight chance that one or more of them might make a trial of electrical motive power, which would not be prejudicial to the traffic of the road at the outstart, when it is, of course, problematical. Electrical motive power is much more likely to be adopted on an entirely new system than on any that are now operated by steam, for the reason that any failures or breakdowns would not cause as much general inconvenience nor really damage the traffic on an entirely new road, where the traffic was as yet unsettled, as on an older system on whose regularity of operation some tens of thousands of people might be absolutely dependent.

So it was thought best to make all estimates for roads not yet completed, in order that there might be a shadow of possibility of the adoption of electricity at the outstart, and that the idea might therefore seem more practicable than if plans were simply made for the substitution of electricity on a line now operated by steam. As has been said before, the former and not the latter way will probably be the path of progress in this direction.

There are three lines now under way in Chicago, the West Chicago Rapid Transit Co., the South Chicago Rapid Transit Co., and the Lake Street Elevated Railroad Co. The first starts at Market Street, between Washington and Randolph, and cuts through buildings and all directly west to Halstead, runs north on Halstead to Randolph, west on Randolph to Ogden Avenue and along the latter to Crawford Avenue, a distance of about five and one-half miles.

The South Chicago line, commonly called the "Alley road," starts at Van Buren Street, and will run when completed a distance of seven and one-half miles, though only about three and one-half is at present under construction. It follows the alley between State Street and Wabash Avenue, the entire distance, from Van Buren to 37th Street.

The Lake Street road starts at Canal Street and runs west on Lake Street to the city limits. It will be extended eventually to Oak Park or beyond, and will be

* A thesis read at Sibley College, Cornell University, May, 1890.

ten miles in length. The grades on these roads are practically level. The stations will average about three to the mile, for all three lines. The South Chicago line and the Lake Street road are built of plate girders and the West Chicago road will use the lattice girder. The tracks will be twelve feet apart.

The train units will be assumed at three cars each, all carrying passengers and with motors in the trucks of the forward car. The assumption will be made that the train is to receive a continuous acceleration up to fifteen miles per hour, at which speed the motors will be extending their maximum horse power. They will continue to exert this maximum power, but accelerate at a decreasing rate, until full speed, or twenty-five miles an hour, is reached. The tractive coefficient is assumed at eight pounds per ton.

The acceleration given the train was assumed to be such that it would attain the speed of fifteen miles per hour within a space of two hundred and fifty feet from the starting point. As will be shown later, this requires an acceleration very nearly equal to that actually ascertained by experiment on the Manhattan Railway, as given by Mr. Sprague, in a paper published in the *Electrician and Electrical Engineer*, in February, 1886.

The weight of an empty passenger car, of the latest pattern, such as are in use in New York and Brooklyn, was given by the manufacturers, the Gilbert Car Co., of Troy, N. Y., as 26,000 lb. It would be somewhat difficult to crowd one hundred passengers into one of these cars (they seat 48), but that will be taken as the greatest possible number, and used in the calculation. The weight of the motor car, with say fifty passengers and its heavier motor trucks, may be assumed at 45,000 lb. To recapitulate:

Weight of empty car	26,000 lb.
Weight of 100 passengers at 130 lb.	13,000 "
Total per car	39,000 "

Weight of motor car loaded, 45,000 lb.
Total weight of train, $45,000 + 39,000 + 39,000 = 123,000$ lb.

Train resistance of 61·5 tons at 8 lb. per ton is 492 lb. The problem is therefore to determine the horse power required to accelerate a train weighing 61·5 tons against a constant retarding force of 492 lb. through a distance of 250 feet that at the end of that distance the train shall have acquired a velocity of fifteen miles per hour or 22 feet per second.

This is a simple problem in dynamics covered by the following formula:

$$\int_0^{s'} Pas = \int_0^{s'} Ras + \left(\frac{Mv'^2}{2} - \frac{Mv''^2}{2}\right)$$

Or integrating,

$$Ps' = Rs' + \frac{Mv'^2}{2}$$

in which P is the accelerating force, R the retarding force, s' the given distance and $\frac{Mv'^2}{2}$ the kinetic energy of the train at the end of the given distance.

$$P \times 250 = 492 \times 250 + \frac{123{,}000 \times 22^2}{64{\cdot}32}$$

using pound, foot, and second as units.

Whence, $P = 4{,}194{\cdot}24$ or practically
$P = 4{,}200$ lb. tractive pull.

The greatest rate of working, and therefore the maximum horse power, will be called for when this velocity of 22 feet per second is attained

$$H\,P = \frac{Pv}{550} = \frac{4{,}200 \times 22}{550} = 171{\cdot}6, \text{ maximum.}$$

This must be delivered at the axle. If 70 per cent. be the efficiency of the motors and gearing, $\frac{171{\cdot}6}{0{\cdot}70} = 245$ electrical horse power will be required at the motor terminals. The time occupied is found thus:

$$s = \tfrac{1}{2}\,vt, \text{ whence } t = \frac{2\,s}{v}$$

$$t = \frac{500}{22} = 22{\cdot}7 \text{ seconds.}$$

Also, $p = \frac{v}{t} = \frac{22}{22{\cdot}7} = 0{\cdot}97$ feet per square second, the value of the acceleration.

In the paper by Mr. Sprague above referred to, he finds that the engine, when drawing a four-car train, exerts its maximum effort when the velocity has reached about 16 feet per second. This he finds to be 163 1 horse power at the axles. By reducing the weight of the train from about 80 to 60 tons, and accelerating continuously up to 22 feet per second, the power required will be but slightly in excess of that required of a steam locomotive; and as the acceleration is about 1 foot per square second in both cases, up to the maximum rate of working, and this maximum is slightly larger with the conditions that have been here assumed, it will be safe to assert that the electric locomotive will get its train up to full speed in as short a distance as the steam engine.

When the maximum horse power has been reached, the product $\frac{Pv}{550}$ remains constant until full speed is attained. That is, as the velocity increases, the accelerating force decreases, and the acceleration will grow less and less. It will therefore require, for instance, a longer time to accelerate from 15 to 30 miles per hour than it did from 0 to 15 miles.

It will be quite sufficient for the purpose if we assume the figures found by Mr. Sprague, regarding the time and space intervals concerned. Grade supposed level.

Average distance between stations	1,722 ft.
Distance run in accelerating to full speed	625 "
Distance run at full speed	808 "
Distance run, slowing to stop	289 "

The average speed in feet per second, for each portion, is about as follows:

Getting under way	19·7
Full speed	29·1
Slowing to stop	14·1
Mean between stations	21·3

We may calculate the time interval consumed from the two foregoing summaries.

Time interval of accelerating.	$625 \div 19{\cdot}7 = 31{\cdot}7$ sec.
" running at full speed	$808 \div 29{\cdot}1 = 27{\cdot}7$ "
" slowing to stop.	$289 \div 14{\cdot}1 = 20{\cdot}5$ "

The average speed between stations, in miles per hour, was found to be 14·7 on the Third Avenue railroad.

The South Chicago road, from Van Buren to 37th Street, is 3·41 miles long, and this distance is to be covered in 15 minutes 18 seconds.

There are nine stops to be made in this interval, and allowing 15 seconds for each stop, there must be subtracted 2 25 minutes from the schedule time. This leaves 13·05 minutes as actual running time, or an average speed between stations of 15 6 miles per hour.

The Manhattan four-car trains, with locomotive, weigh about 98 tons, loaded. A train of the size considered here will weigh 61·5 tons, or less than two-thirds this amount. It is safe to say, therefore, that the required average speed of 15·6 miles per hour can be obtained with no greater expenditure of power than the speed of 14·7 miles with a train 1½ times as heavy.

So the next thing to consider is the design of the electric motor car.

The general outline of the construction preferred by the writer has already been indicated. The idea is to have a single motor in each truck, with two armatures; the armature pinions to mesh into a large gear between them, said gear to be fast to a shaft that has crank disks at each end outside the wheels, and the crank pins to take hold of parallel rods which drive the wheels, as the middle drivers of a mogul locomotive actuate the other two pairs. The central shaft is also to carry the motor, and passes through the center of it, so that the motor is balanced, and by means of springs attached to the frame, has at all times an elastic contact between the gear and the armature pinions.

Two motors of this type aggregating 170 horse power can each be placed in a truck of convenient size, having 42 inch wheels. It is a combination of Mr. Sprague's and Mr. Field's ideas, and the aggregate power of the two trucks is sufficient for propulsion under the assumed conditions. For larger powers, Mr. Sprague's system, having a motor swung on each axle, would probably be required; but for powers inside of 200 horse power the method here shown would save weight considerably.

There being four armatures per car, the 245 electrical horse power necessary would be about 62 horse power to each armature. Operating with 600 volts at the armature terminals, the current would be about 77 amperes. The armature must therefore be designed to generate about 600 volts, and to carry a maximum of 77 amperes. When running at maximum speed, the peripheral velocity may be taken at 3,200 feet per minute. The magnetization is, of course, weak at the maximum speed, and the machine must be so designed that the weakest field can bring up the E. M. F. of the motor nearly to that of the line.

When using a shunt motor and governing the speed by the field, the magnetization varies inversely as the speed. The maximum magnetization may be taken as 15,000 lines. It sometimes runs up in railway practice to 17,000 or even 19,000 lines, but this excessive saturation requires so much more energy in magnetizing force, that it can hardly be called economical. By Hopkinson's formula the number of volts per foot of wire is obtained, assuming 70 per cent. of the armature surface to be covered by the pole pieces. The magnetization at maximum speed will be assumed at 7,000 lines per square centimeter.

$$\frac{7{,}000 \times 3{,}200 \times 30{\cdot}5 \times 0{\cdot}70}{10 \times 60} - 2{\cdot}43 \text{ volts per foot.}$$

As the two sides of the armature each generate 600 volts, $\frac{600 \times 2}{2{\cdot}43} = 492$ feet of active wire on the armature, or $492 \times 12 = 5{,}904$ inches of active wire, on the periphery of the armature will be required.

In order to reduce the ratio of gearing as much as possible, to save noise and wear, the diameter of the armature, which is of the Gramme type, was assumed as 17 inches, which is as large as the vertical space available for this type of motor will permit. This gives a circumference of 53·407 inches.

To carry the current of 38·5 amperes, the two sides of the armature being in multiple, at a density of 500 circular mils per ampere, will require No. 7 B. & S. wire, whose diameter, including insulation, is 0·73 inch.

This will permit 308 wires per layer on the armature circumference. Assuming 2 layers, or 616 wires,

$$\frac{5{,}904}{616} = 9{\cdot}58 \text{ inches, the length of the ring.}$$

But as the number of wires per layer will not when divided by four give an even quotient, we cannot make the commutator bars come out as they should. But 304 will, when divided by 4, give 76, an even number, and a convenient one for the number of sections in a commutator. Therefore, assuming 304 wires per layer, or 608 altogether, we can obtain a new value for the length, which now becomes 9·75 inches. And there will be 8 turns of wire in each section of the ring.

The air gaps will have a length of ⅛ inch each, or 5 08 centimeters for the four. From this drawing it will be seen that the lines of force pass through the two armatures in succession, and then branch into two sections, one above and one below the armatures. One advantage of this construction is that by having consequent poles, there is less scattering of the lines of force, and this form is, by reason of its symmetry, less liable than most others to losses of this kind.

Now the number of turns on each branch of the field is next to be ascertained. By measurements on the drawing of the field magnets, as shown in the blue print, the length of each branch of the magnetic circuit, including the armature, is 235 centimeters, approximately. The length of the air gaps is, altogether, 5·08 cm.

We may assume the maximum magnetization as 15,000 lines in the iron and 14,000 in the gaps.

When $B = 15{,}000$, $H = 28{\cdot}5$, for wrought iron.
$235 \times 28{\cdot}5 = 8{,}122{\cdot}5$ *C. G. S.* units, *Fm.*
For the gaps, $5{\cdot}08 \times 14{,}000 = 71{,}120$ *C. G. S.*, *Fg.*

	8,122
	71,120
Total *F*.	79,242 *C. G. S.* units.

$$\frac{79{,}242}{1{\cdot}26} = 62{,}890 \text{ ampere turns.}$$

So far the armature reaction, whose tendency is to demagnetize the field by setting up an opposing magnetization, has not been taken into account.

Mr. W. B. Esson, in a paper read before the Institute of Electrical Engineers, in England, stated that as a fair average, 33 per cent. of the ampere turns on the armature should be added to the field cores, in order to overcome this effect; and it will be best to make this allowance. Each side of the ring has about 38·5 amperes flowing through it, and on each half there are 304 turns, making 11,704 ampere turns; 33 per cent. of this number is 3,862.

$$62{,}890 + 3{,}862 = 66{,}752 \text{ ampere turns.}$$

If ten amperes be allowed as the maximum magnetizing current, there will be 6,675 turns of wire on each core. Allowing 1,000 circular mils per ampere, the size of wire used will be No. 10 B. & S. The space occupied by 6,675 turns of this wire need not be more than 100 square inches in cross section. As the winding on each limb is divided in half, and allowance is made for a coil of three inches in depth, each coil will be between sixteen and seventeen inches long.

The matter of ratio of cross section of the core to that of the pole pieces is a question as yet not entirely settled. It would seem in this case as if a depth of 4¼ inches would be sufficient. There would then be about 1,470 feet of wire on the armature, weighing about 92·4 lb.

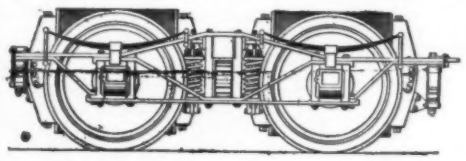
The armature resistance would be that of one-fourth this length of wire, or about 0·183 ohm.

The cross section of the field core is as shown in the drawing, about 90 square inches. This may seem rather large, but having only a drawing to go by, which was presented to me by Mr. Sprague, this was followed with respect to general dimensions in cases of doubt.

The length of an average turn of the field winding is about 65 inches, with core dimensions as taken in the drawing. The total number of turns is $6{,}675 \times 2 = 13{,}350$. This is equivalent to a total length of 72,312 feet. The resistance of this length would be 72·3 ohms, which would not permit the passage of the requisite magnetizing current at the given pressure, 600 volts. But if the two pairs of coils be put in multiple, the resistance will permit the use of a rheostat.

Such is the outline of the general design of the motor. To work out every detail of construction would take more time than it has been possible to devote to this thesis.

The appearance of the truck can be fairly well represented by the drawing. To avoid taking up head



room and at the same time retain strength, the cross beam of the truck on which the end of the car rests is composed of two six-inch heavy I-beams, 90 lb. per yard. The velocity ratio of armatures to wheels should be between 4 and 5, instead of 6, as shown.

The scale of drawing for the truck, etc., is 1½ inches to the foot.

The axles are 4 inches in diameter, the central crank shaft 3 inches, and the armature shafts 2½ inches.

The total height of the truck is about 48 inches. The ends of the car are to be raised accordingly, for a distance of about ten feet. The middle portion will be at the usual level, 36 to 38 inches above the top of the rail. Each end is to be fitted up as an engineer's room. The necessary apparatus would be main cutout, a field cutout, a regulating field rheostat, and reversing switch, with an ammeter and voltmeter, just as there are pressure gauges in a locomotive cab. In fact, an intelligent engineer would receive great assistance in operating the motors with the ammeter before him. There should also be a "throttle," or resistance of 8 or 9 ohms, which would be thrown in at the start and prevent the burning out of the armature before its speed would be sufficient to generate a counter electromotive force. The "throttle" and field rheostat could be placed under the middle of the car, or there might be separate ones for each truck, all operated from one set of levers, which would have duplicate handles in each end of the car.

Such a locomotive would answer very well for duty on the South Chicago and the West Chicago roads. On the Lake St. road, the speed is to be somewhat higher, and the motor truck devised by Mr. Sprague would be preferable, as it is much more powerful.

There is, perhaps, not much to commend the form of motor and truck just discussed, save its comparative lightness. The writer cannot claim originality for the type of motor employed, nor for the idea of the crank shaft and side rods, but so far as is known, their combination as herein indicated has not been previously proposed. The two fundamental ideas are both excellent, and their combination, for the particular purposes and conditions, ought to be a good one.

The Lake St. railroad is, so the writer was told, to be operated at an average speed of twenty-five miles an hour, with a maximum of thirty miles. The structure is very solid, and evidently capable of carrying the strain.

To operate at this speed would require not less than 300 horse power for a train of the size we have been considering. For example, to accelerate a train weigh-

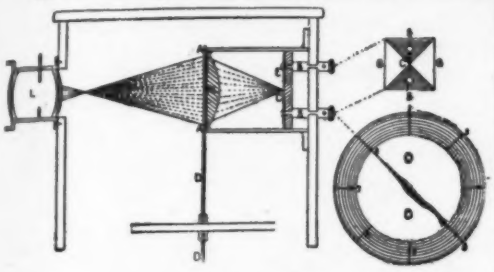
ing 65 tons to a speed of twenty miles per hour within a space of 400 feet requires 276 horse power. It would certainly not be wise to count on less than this. Mr. Sprague designed a 300 horse power motor car, to which reference has several times been made. An illustration of the motor truck is shown herewith, and the writer would recommend its adoption where larger powers than usual are required.

(To be continued.)

SUTTON'S SYSTEM OF TELEPHANY.

THE discoveries of Graham Bell, Hughes and Van Rysselberghe are now furnishing so satisfactory a solution of the question of hearing at a distance that it was but natural that the idea should occur to join to it, as an agreeable complement, vision at a distance. The question, however, has as yet lost nothing of its absolutely hypothetical character. The persons who have grappled with it have been for the most part bold rather than learned. No one, we believe, has comprehended and stated the problem of vision at a distance as has Mr. Henri Sutton, whose interesting article we reproduce, in adopting the appellation *Telephany* that he proposes.

The art of telephony is simple relatively to that of



FIGS. 1 AND 2.

telephany. It is a question of transmitting a series of waves of varied frequency and length, and the consecutive character of the sound lends itself admirably to electric transmission. Telephany, on the contrary, meets at the outset with a great difficulty—it is that of a surface or of a plane, whose every appearance, variable at every instant, that it would be a question of observing.

The problem presents itself thus: to find a process for making the varied aspects of a plane surface determine a succession of electric currents, and, by means of these, to constitute, so to speak, a reproduction of the original surface. That is to say, having an optical image that presents itself as a surface, to translate it into a succession of electric currents, and through the effect of these, obtain the impression of a surface having the characters of the primitive image.

Before showing how to attack this apparently impossible problem, I shall mention a probable method of transmitting a photographic image. If, upon thick paper, we make what photographic operators call a negative of a portrait and transfer it photo-lithographically to zinc and utilize the latter for transmission by an autographic telegraph, the desired result will be reached. In fact, if we apply our knowledge of copper plate engraving to telegraphy, we shall be in possession of a means of transmitting the photographic portrait of any one telegraphically.

With a negative plate, we can obtain a print upon zinc or copper covered with sensitized albumen or with bitumen, and afterward freed of the albumen or bitumen according to the case, by washing with water or turpentine. After development, on placing the plate under the style of any autographic telegraph, we shall obtain a facsimile of the portrait at the receiver. I have used the term negative plate because it is a commercial appellation. In reality, a positive plate would be necessary.

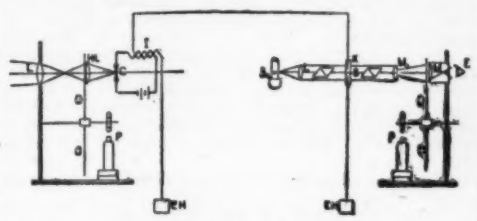
But we can go farther. Instead of receiving the facsimile upon chemical paper, as in Caselli's autographic telegraph, we can make use of the receiving style to perforate a sheet of thin paper through the electric spark by means of an induction coil continuously operating, but introduced into the circuit by the current transmitted. On then passing a roller charged with thick ink over the perforated paper placed upon a stone or a zinc plate, we shall have a printing plate. The portrait will be transmitted and reproduced for electrophotographic and mechanical printing.

All this, however, is not the point of telephany. It is the object of this to transmit the image of objects in motion as we see them in the camera, with nearly their natural color.

I have devoted several years to the study of the problem, and five years ago I devised the following system, as my friends in Victoria can testify to. My system may be of service to those who are making researches in the same direction, and I think that it offers, with sufficient approximation, a solution of this difficult problem. At all events, if it is not in the shape of a real solution, I think that it is in this direction that the solution of the problem of telephany will be met with.

Transmission.—A rapid photographic objective, L (Figs. 1 and 5), produces at A A a strongly illuminated aerial image.

A light metallic disk, D D (Figs. 1, 2, and 3), revolves at a constant velocity of at least 65 times per minute, regulated by a Lacour phonic wheel and a tuning fork, as in the Delany multiple telegraph. A glass plate or any insulator whatever, G (Figs. 1, 3, and 5), supports on its surface two triangular pieces of metal, S S, separated from each other by an interval in which, at C, there is a little lamp black or selenium, the electric resistance of which is capable of changing through light. Compressed lamp black is probably the best material. The disk, D D, presents a series of apertures, 1, 2, 3, 4, 5, 6, 7, and 8, arranged spirally, starting from its center. There should be a large number of these apertures, and each one, moreover, should be alone in its turn in the field of the image, A A.

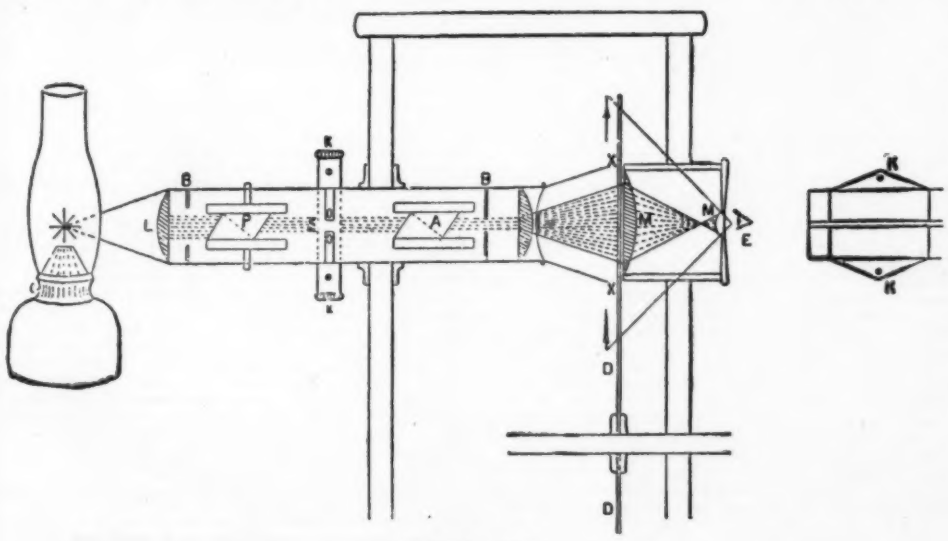


FIGS. 3 AND 4.

The lens, R L (Figs. 1 and 5), is the most important part of the transmission. I call it the regulating lens. It receives upon its plane face the aerial image given by the objective, L, and its focal distance is such that all the rays which reach it through the perforated disk converge at the same point or focus, C. Its function is to lead in succession each of the rays between the extremities of the circuit formed by S_1, E_1, C, E, S.

Under the influence of the regulating lens, the entire image, A A, acts successively and causes the resistance of C to vary according to the illumination or shading of the points of the image. We thus solve the great problem of the turning of a plane image into a series of currents of variable intensity, by bringing C successively under the influence of the entire image in a tenth of a second, in reconstructing the image at the receiver at the same time.

Reception.—The artificial source of light, S (Figs. 4 and 5) furnishes a ray directed by the lens, L, through two Nicol prisms, P A, and the lens, M, and which, amplified by M M, is received by the ocular, E. It is absolutely necessary that the ray shall be received through the intermedium of an ocular system. The



FIGS. 5 AND 6.

presence of a diffusing screen at X X would be fatal, by reason of the delicate nature of the effect sought.

A perforated disk, D D (Fig. 4), like that of the transmission, revolves synchronously with it.

The exciters, K K (Figs. 4, 5 and 6), having a small space betweeen them, are placed in a sulphide of carbon reservoir, S. Upon turning the Nicol prism, P, to an angle of 45°, it is regulated to the position of extinction.

The exciter, K K, forms part of the secondary circuit of the transmitter, that is to say, of the line. The electrostatic effect produced upon the sulphide of carbon under the action of the currents induced by the transmission is of a nature to cause the polarized ray to turn to a variable extent, and consequently a variable quantity of light will reach the eye at E.

It is evident that the variable emissions of light will be seen in a position similar to that of the primitive image, by reason of the synchronism of the disks.

The reception, then, is founded upon Dr. Kerr's discovery of the rotation of the flame of polarization of the light produced by an electrostatic field acting upon a medium. There seems to me no doubt that the induced electric currents will act in a tenth of a second, and the question is to know whether the action determined at O O will suffice to produce an observable effect or one that may become so on making the light traverse either a reservoir (as in Fig. 5) or a tube of sulphide of carbon of a certain length. In admitting that telephany is thus founded upon a correct principle, it remains to know whether the quantitative effects of the physical phenomena utilized are sufficiently great.

I think that the transmitter may be considered as good enough in the present state of our knowledge, and that it may prove successful. It at least offers chances of success.

As for the receiver, that is a question of size. The quantity of light necessary to make an impression on the eye may be very small when it is received by optical apparatus, and in fact much too small to produce any effect upon a screen; and a quantity of light insufficient to produce any visible illumination may, when received by an ocular, give the impression of a luminous point.

I regret my inability for the moment to mention the name of the inventor of the revolving disk. Apart from that the project as a whole is original, and I devised it at Ballarat (Victoria).—*La Lumiere Electrique.*

CURE FOR BALDNESS.

PERSISTENT DANDRUFF, ACNE, AND THE SEBORRHŒA OF UNNA.

By EDWARD BLAKE, M.D.

Part I.—Persistent Dandruff and the Seborrhœa of Unna.

BEFORE leaving town for my usual summer holiday, I observed in the correspondence columns of the *Lancet* a request for a cure for obstinate dandruff. If your correspondent should chance to see this somewhat tardy reply, it may interest him to hear that some months ago I was made acquainted with a method of meeting this troublesome disease by a medical friend, Dr. Shuldham. I must admit that the plan has proved to be a remarkably successful one. Cases which had been running a tedious course of years' duration untouched by ordinary treatment have, provided the heart action be good, shown marked improvement ere a week has elapsed, and have soon after reported a cure. This question of dandruff is not quite so simple as we might suppose. Its natural history, while full of interest, is really very complex. There is still a great deal to be learned as to the precise pathology of various forms of dandruff; on the other hand, the researches of Unna, of Hamburg, have thrown a large amount of light on the subject, and have at least taught us how much there is still to be known about this much neglected disorder.

To Unna, I believe, belongs the credit of first pointing out that dandruff is essentially parasitic, and therefore contagious. This has been confirmed in the fullest manner by excellent clinical evidence. There seems to be little room for doubt that scurf does not usually appear spontaneously, that it is conveyed from a definite source. The hairdresser's brush and the toilet accessories of hotels, clubs, etc., are probably frequent offenders among men. With the other sex a possible method of convection is as follows: A maid servant uses her mistress' hair brush, and after a certain lapse of time the lady's scalp begins to itch, especially along the line of parting. From the mother it does not take long to spread to the children. It is possible that a microphyte may actually enter the sebaceous follicle belonging to a hair sheath, setting up the severe irritation and its accompanying phenomena, to which Unna has given the name of "seborrhœa." But the following course appears to be more probable. A given person labors under a certain dyscrasia, often associated with an indolent heart action. In this state the sebum thickens from a fluid oil to a solid fat, as it does in acne. The orifice of the follicle becomes blocked with this fat and with accumulated epithelial cell debris. An appropriate nidus is thus formed for the retention and elaboration of the microspore, the clinical sign of its nidation and development being intense itching. The sebaceous secretion from this time grows more and more dense and consistent. Degenerated epithelium cells are proliferated with great freedom, and at last the formation of sebum is altogether abolished. After this three sequent phenomena may be recognized: 1. The hair grows dry, harsh, and brittle, owing to the arrest of secretion of the normal sebaceous material. 2. The copious production of epithelial scales in and near the mouth of the sebaceous duct leads to great accumulation round the hair, which, compressed and strangled, soon breaks off. The third and last process is as follows: Vast accumulations of imperfectly formed and badly elaborated epithelium scales, having first filled the cavity of the root sheath, begin to protrude from it in the form of a domed hillock, brownish gray in color. These can be readily detected in advanced cases by the unaided eye. These camel-colored hillocks are formed of diseased epithelium scales, loosely held together. When scattered by the nail, applied to relieve the itching, or by the hair brush, they form the bran-like material commonly called "scurf." These scales may themselves be the carriers of contagion. We often find them spread over much larger geographic areas among the gentle than we do with the simple.

Among ladies they are soon removed and freely disseminated by diligent brushing. I have seen them deposited on the outer portion of the eyebrow, and it may occasionally be seen that the hair of that part has perished. The intermammary region is a very common site. Again, they are sometimes arrested in their downward course by the prominent upper portion of the breast, where the crescent of brown patches which they give rise to may be mistaken for pityriasis or for chloasma. This condition is sometimes called "lichen circumscriptus." The brown spots are frequently seen on the shoulders and in the interscapular area. Many gaps in the minute pathology of this much neglected disease remain to be filled up, but enough has been said to show that there is no royal road to the cure of dandruff.

To be able to cope successfully with this complaint it is needful to study its natural history. Dr. Shuldham's treatment is as follows:

The head should be first well washed with hot water and alcohol soap. Alcohol soap consists of two ounces of pure soft soap, half an ounce ... rectified spirit of

wine, and ten minims of oil of lavender. This formula seems simple enough, but it is very difficult to get this soap properly prepared. One reason for this is that a large amount of cotton oil is now introduced into this country, and sold, with the addition of a little olive oil, as "best Lucca." The soap is afterward carefully washed away with plenty of hot water, and the head is then thoroughly dried by means of a warm soft cloth. When the head is quite dry, a glycerole of tannin, strength from 10 to 30 grains to the ounce, according to the gravity of the case, should be freely and firmly rubbed into the scalp. If tannin fail, resorcin may be tried, but the tannic acid generally does the work. This process should be repeated once, twice, or thrice a week, as the symptoms may require.

After the total removal of the dandruff, a daily dressing with carbolic oil favors the growth of fresh hair: ten grains of absolute phenol, one drachm of oil of cinnamon, and one ounce of olive oil. Warm together and decant off. Apply freely every day.

Part II.—Acne, and Its Relations with Intractable Dandruff.

I come now to a matter of extreme interest; it is the method of removing recurrent acne pustulosa—a confessedly obstinate, and certainly a most disfiguring, disease. I have shown that scurf may be an acquired disease of contagious character. Though we might have a suspicion that the parasitic pathology of the new Hamburg school may greatly modify, even if it fail to revolutionize, modern cutaneous medicine, yet the whole matter to many of us retains some of the characters of a startling novelty. It has not hitherto, as far as I can ascertain, been thought that any clinical relationship could exist between scurf and pustular acne. Yet there seems to be some ground for suspecting such a connection, as I shall presently seek to show, by giving the history of two exceedingly suggestive cases which I have been recently watching, and whose details I will briefly narrate.

Case 1.—I had treated for two years a lady aged thirty-five for recurrent acne pustulosa of the back. She was a tractable patient, and submitted loyally to strict diet rules. All the pustular remedies that I had ever heard of were given, and the result was "a brilliant failure." I called to my aid a distinguished skin specialist, and followed his directions scrupulously, but alas! with an equally unsatisfactory result. At this stage, acting on the advice of Dr. Shuldham, without any reference to the acne, but with a view to removing a dandruff which threatened baldness, I applied alcohol soap, followed by glycerole of tannin. The result was most instructive to me. With two applications per week the scurf, which was a very old business, soon disappeared, and to my great surprise the dorsal pustular acne went with it.

Case 2.—Soon after this a physician of forty-eight years of age consulted me as to whether anything could be done for his baldness. He stated that he did not see why he should have alopecia, as his family did not become bald even in advanced life. Dr. Shuldham kindly examined him with me. We found the scalp freely movable. Hair, otherwise healthy, was very thin along the parting. There was a history of intense itching in that locality five years ago, and after that the baldness began to set in. This irritation subsided under the use of carbolic oil, but the hair was not reproduced. He continued to use the phenol oleate, as without it so much scurf was generated. His back was decorated with pustular acne and with a great number of scars of former spots (acne indurata). He volunteered the information that four days' indulgence in fat ham would always be followed by a pustule on the face. This apparently unimportant observation as to the relation between acne and the absorption of a carbo-hydrate undergoing a slow process of oxidation supplies, as presently will be seen, a very important link in the evidence for elucidating the life history of acne pustulosa. A form of treatment was adopted in this case resembling that employed in Case 1, and with similar satisfactory results. The scurf disappeared, and with it went the acne pustulosa of thirty years' duration. This was without internal treatment in either case.

Now, let us ask, what was common to these two cases, and what was the *rationale* of their cure? In both there was old existing seborrhœa, dating probably from puberty. This catarrhal condition of the sebaceous follicles of the scalp affords an appropriate nidus or supplies suitable soil for the micrococcus or the microphyte which induces dandruff. The methods of growth and of distribution have been already considered. The dandruff is distributed by the comb, the brush, and the finger nail, carrying with it the peculiar causative microphyte. Where it encounters the oily or viscid material oozing from a sebaceous follicle about to pass into the comedone stage it is mechanically detained, and if not disturbed by hot ablutions, by vigorous toweling, or by the maneuvers of the Turkish bath, it sets up a specific irritation known as acne papulosa. If through the presence of bacteria the sebum decompose and break up into a variety of volatile principles and of fatty acids, some of these being possessed of a horribly fetid odor, the resorption of these acts, like the butyric and other acids of the ham fat, by inducing suppuration or local sphacelus with a development of the usual staphylococci, streptococci, and allied organisms found in abscesses. Papular acne is most common, as pointed out by Dr. Frank Payne,* on the parts formerly endowed with hair, but now, possibly through evolutionary changes, bereft of it. It is found, as I myself have observed, on the fixed points of the skin, while it is rarer on the mobile portions. It is unknown under the chin, and this is especially noteworthy, for that region is protected by the projecting jaw from the impact of scurf scales descending from the hairy scalp. It is an old clinical observation that fat introduced into a stomach deficient in vitality is prone to produce the exciting cause of pustular acne. For example, it follows, in certain people, indulgence in rich pastry and old cheese. That the disturbing element is an acid seems likely from the great success that sometimes follows the use of free doses of the alkaline salts. We know that other carbohydrates, besides those already named, are credited with the power of setting up acne of the pustular type. Among these, the commonest are malt liquor and sugar, especially when their ingestion does not follow outdoor exercise. With regard to the malt liquors, there is of course another possible explanation of the occurrence of acne. It is the introduction of sulphur and its compounds. There are at least three methods by which sulphur may be introduced into beer. The hops are dried while exposed to the fumes of nascent sulphurous acid; barrels are washed with calcium sulphide to freshen them, and the best beer-making waters, as those of Burton, are rich in the same salt. As we have to deal with two contributory causes of acne pustulosa, seborrhœa as a predisposing and scurf as an exciting cause, the question arises: Shall we attack these (*a*) in their chronological order, (*b*) together, or (*c*) in reverse order? The practical rule appears to be to destroy the dandruff first, then see to the seborrhœa. Acne punctata may be removed by means of an ammonia soap which I devised ten years ago for the purpose. Its composition is as follows: From ten to thirty minims of liquor ammoniæ (according to age), one drachm of ether, one ounce of soft soap. To be kept air tight. First foment a small portion of the skin with very hot water, then apply the soap firmly with the ball of the thumb, as if cleaning off varnish from an old oil painting, and very quickly wash away all vestiges of soap. Great care must be taken in using this soap on sensitive parts or on delicate skins, else pretty severe erythema may be set up. Careful dieting, total abstinence from every form of alcohol, sharp outdoor exercise, hot bath, Turkish or electric baths, assist matters. Systematic lung hygiene, *i. e.*, enforced expiration followed by prolonged pernasal inspiration, brisk towelings, general effleurage or skin rolling, sedulous avoidance of excitement, of ices and cold beverages, no sea bathing, and the exceptional use of the cold bath, soft woolen clothing, etc., and the employment of sulphur or arsenic as internal remedies according to indications—these are the main outlines of treatment, to be modified by the special exigences of individual cases.—*The Lancet.*

* See an admirable post-gradnate lecture on acne, a *resume* of which may be found in *The Lancet* of Feb. 15, 1890, at p. 330.

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